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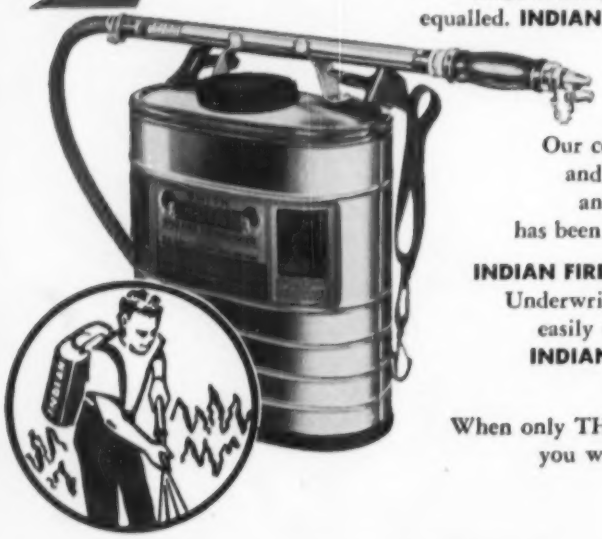

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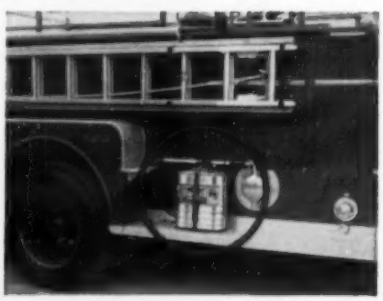

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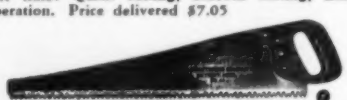

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Forest Growing Stock

L. S. Gross
Division of Timber Management,
U. S. Forest Service, Washington, D. C.

MANAGEMENT PLANNERS may underestimate the importance of the amount, character, and distribution of the growing stock on the working circle for which a management plan is being written. The inventory of merchantable timber may or may not be segregated by age classes or condition classes and there may be more or less information on the area and distribution of pre-merchantable stands. If the inventory was well planned, however, all needed information on the present growing stock should be available. The management planner must develop from the data at hand prescriptions under which the working circle will progress toward a condition of maximum attainable productivity, while yielding continuous crops of marketable products. The purpose of this discussion is to focus attention on the need for regulating the growing stock and to suggest practical means of doing so.

Growing stock is defined as "the sum (in numbers or volume) of all the trees growing in the forest" (*4*).

This definition raises questions regarding minimum size of trees included and unit of volume. The usual practice is to include only those trees above a stated minimum diameter. Volume should be specified as cubic feet, cords, or board feet. If growing stock is expressed in board feet, the log rule also should be given, as for example, Scribner Decimal C or International ¼ Inch. The Forest Survey (*5*) definition of growing stock includes size class of timber and unit of measure: "Net volume in cubic feet of live sawtimber trees and live poletimber[1] trees from stump to a minimum 4.0-inch top (of central stem) inside bark."

For use in national-forest management planning it seems best to consider that growing stock includes all of the timber on commercial forest land in the working circle. Under present conditions this ordinarily means timber of saw-log size above a stated minimum d.b.h., expressed in MBM, Scribner Decimal C rule. On some eastern and southern working circles, however, well-developed markets for pulpwood and other small size material indicate the desirability of including in the growing stock all trees which are marketable for such products. This means that the growing stock will include trees 5 inches d.b.h. and larger. The saw-timber component usually is stated in board feet, to which is added the cordwood component expressed in cords and converted to board feet. Under these circumstances consideration should be given to expressing growing stock and allowable cut in cubic feet. If the timber is to be sold by the board foot or by the cord, or both, the cubic-foot volume can be converted and segregated by the use of appropriate factors in developing the cutting budget. As management becomes intensified refinements such as this certainly will become necessary.

A question frequently asked is whether the growing stock figure refers to the volume after cutting, that is, at the start of the cutting cycle, or before cutting, that is, at the end of the cutting cycle. That question is pertinent to the growing stock of a particular stand or compartment, but not to a working circle. Under even-aged management the growing stock value for an individual stand or compartment may vary from zero, just after a harvest cut, to the volume at rotation age. In uneven-aged management the growing stock value for a particular stand or compartment may vary over a much narrower range, since the maximum reduction, under full stocking, will be only the volume equivalent of mean increment times length of cutting cycle.

This discussion pertains to the growing stock value for a working circle. The time element is not significant, because the working circle consists of stands in varying stages of development. Cutting, mortality, and growth are always in progress in various parts of the working circle. Thus it is not necessary to relate the volume of growing stock on a working circle to time of cutting. When speaking of actual growing stock it is well to refer to date of inventory.

Normal Growing Stock

When even-aged silviculture is prescribed, the normal growing stock for a working circle may be calculated from normal yield tables. Since the usual practice in the construction of a normal yield table is to search out and measure the most heavily stocked stands which can be found in the several age classes, there is a widespread tendency to disregard such tables as representing values which never can be attained over large areas. Normal yield tables, however, serve a very useful purpose. They show maximum possible production. Further discussion of this point and of the use of normal yield tables may be found in textbooks such as those of Matthews (*3*) and Chapman (*1*). Another good reference is Briegleb's "The Use of Yield Ta-

[1]Saw timber and pole timber also are defined in the Forest Survey Manual.

TABLE 1.—NORMAL GROWING STOCK—110-ACRE DOUGLAS-FIR FOREST

Area	Age	Trees		Volume		Volume by age groups	
		Per acre	Total	Per acre	Total	Per acre	Total
Acres	*Years*	*Number*	*Number*	*MBM*	*MBM*	*MBM*	*MBM*
10	10	—	—	—	—	1.2	48
10	20	—	—	—	—		
10	30	6	60	.3	3		
10	40	37	370	4.5	45		
10	50	79	790	12.4	124		
10	60	118	1,180	23.8	238	29.3	1,171
10	70	139	1,390	35.2	352		
10	80	148	1,480	45.7	457		
10	90	149	1,490	55.0	550		
10	100	145	1,450	62.8	628		
10	110	[1]69.5	695	[1]34.7	[1]347	50.8	1,525
110	—	—	8,905	—	2,744	—	2,744
Average	—	81.0	—	[2]24.9	—	[2]24.9	—

Source of data: U. S. Dept. Agric. Tech. Bul. 201, The Yield of Douglasfir in the Pacific Northwest, by Richard E. McArdle, et al, 1930, revised 1949.
Site Index 140 (Table 1), based on total height of dominant and codominant trees at age 100.
Rotation 110 years (Table 9), based on culmination of mean annual increment at 630 board-feet (Scribner rule) per acre per year.
Number of trees per acre (Table 4) 12 inches d.b.h. and larger.
Volume per acre, board-feet, Scribner (Table 4), in trees 12 inches d.b.h. and larger.
[1]One half tubular value because this age class will be cut in this period.

[2]By short formula: $GnA = \frac{Yr}{2} = \frac{69.4}{2} = 34.7$ M.

bles in Predicting Growth, Mortality and Yield," which was prepared for the 1949 Forest Service Management Plan Conference. It appears in the appendix of *Timber Management Plans on the National Forests* (*2*).

Matthews (*3*) aptly states, "It is a recognized fact in practical forest management that the growing stock of a regulated normal forest as calculated from a yield table is greater than we can expect to attain with actual forests under management." Nevertheless, the determination of normal growing stock for a working circle is an important step in management planning. The actual growing stock, as determined by the timber inventory of the working circle should be compared with the calculated normal growing stock. Working circles which carry heavy overmature stands usually have a present growing stock which exceeds the normal value. Even though normal growing stock cannot be attained under management, it is highly desirable to determine this value in order to decide where to set the goal of "desired growing stock" which is discussed later.

The textbooks contain descriptions and illustrations of various ways to determine normal growing stock. The quick formula for obtaining the normal growing stock for a forest of R acres is

$$Gn = Y_R\left(\frac{R}{2}\right),$$

where Gn represents normal growing stock; Yr, yield per acre at rotation age; and R, rotation age in years. If GnA represents normal growing stock per acre the formula may be simplified to determine the average growing stock per acre:

$$GnA = \left(\frac{Yr}{2}\right)$$

This formula is based on an erroneous assumption that current annual and mean annual increment are the same throughout the rotation. It will give reasonably close approximations of total cubic-foot growing stock, but always produces excessively high values for board-foot growing stock. More accurate values may be derived by the summation method, which involves adding the normal yield table values for each of the several age classes. If a normal yield table showed yield values for each year from 1 to 100 and rotation were 100 years, the normal growing stock per acre for a 100-acre forest would be the simple sum of these per acre values for each year. Usually, however, the yields in normal yield tables are shown per acre for age class values at 5- 10-, or 20-year intervals. In this case each value must be multiplied by a factor equal to the age class interval.

The calculation of normal growing stock by the summation method is shown in Table 1.

Rotation must be established by types or working groups prior to calculation of normal growing stock. When a management objective is production of maximum volume yields, rotation should be fixed at the age of culmination of mean annual increment. When quality of product is important, rotation may be extended one or more decades to provide for value increment. Variations in site quality within the working circle also must be considered. When the differences are not great, an average rotation may be used. When a working circle includes significant areas of two or more site classes with widely varying yields, however, normal growing stock may be calculated separately for each site. Procedure for doing so is discussed later.

The normal number of trees per acre, by age classes, also is important, since volume, taken alone, is an inadequate measure of growing stock. Not only numbers of trees, but also distribution by diameter classes is important. Most published yield tables include stand tables, showing numbers of trees by diameter classes and by years of age. In Technical Bulletin 201, Douglas-fir stand tables are given by sites. As with other normal yield table values, it is important to remember that stand tables such as this represent fully stocked unmanaged stands. When calculating desired growing stock for managed forests, weight should be given to the effects of intermediate cuts on the number and size of the trees which make up the stand at

any given age. The managed forest should have fewer and larger trees per acre, at least during the latter third to half of the rotation, than an unmanaged stand of equivalent age.

A useful calculation is the normal growing stock volume by periods (roughly thirds) of the rotation. It is helpful to compare present growing stock with normal growing stock by broad age groups. In the example of the Douglas-fir working circle it will be noted that the normal growing stock for 110 acres is 2,744 MBM. About 55 percent of the volume is in the oldest age group (90 to 110 years); 43 percent in the intermediate age group (50 through 80 years); and very little volume in the youngest group (10 through 40 years).

The example of calculation of normal growing stock deals with even-aged management. For a managed all-aged or selection forest, where harvest cuts are made by the tree selection method, normal growing stock theoretically should be the same as for a forest managed on an even-aged basis. In a normal selection forest all age classes are present in volumes comparable to these in a normal even-aged forest, but they occur in intimate mixtures throughout the forest, rather than in separate stands.

Desired Growing Stock

Since normal growing stock is unattainable over areas the size of a working circle, the management plan should fix a goal of regulation which may be termed "desired growing stock." This matter should be given considerable study. The goal should be reasonably attainable under the type of management which can be given the working circle. It must be high enough to utilize the growth capacity of the land to the extent that it is practicable to do so.

A good way to express a desired growing stock is as a percentage of normal growing stock. It seems doubtful that any national forest working circle can be managed so as to carry perpetually more than 80 percent of normal growing stock. On the other hand, it seems reasonable to assume that the objective should be not lower than 50 percent of normal growing stock on any working circle. The need for forest products now, and in the future, is so great that the capabilities of forest lands should be used to the geratest practicable degree.

Perhaps the best way to fix the objective called "desired growing stock" is through observation and analysis of results of a series of continuous inventory and growth plots which are remeasured periodically. Comparison of the stocking of such plots with normal yield tables values should develop a reduction factor to be appied to normal growing stock. Since only a few working circles are equipped with such a series of permanent plots it undoubtedly will be many years before this method can be given general application.

Much information can be gleaned from inventories for management plans or for timber sales. Temporary plots may be used to determine the existing characteristics of the stands on the working circle. Data on number of stems and volume per acre of the various age classes represented on the working circle, from which stock and stand tables may be prepared, will be found useful in fixing the goal of desired growing stock. While the final figure may be a total volume of all species for the working circle the data should be developed by species, types, age classes, and sites. If it is not practicable to deal with 10- or 20-year age classes, broad age groups representing perhaps thirds of the rotation may be used to good advantage.

When dealing with uneven-aged silviculture, desired growing stock values can be developed by the study and measurement of existing stands. This procedure must rely heavily on judgment. Stands which appear to be representative should be selected for sampling. Among the criteria should be (*1*) an intimate mixture of age and size classes, (*2*) representation of the several species in about the same proportion that they occur throughout the type, (*3*) avoidance of abnormal numbers of overmature and cull trees, and (*4*) as complete a canopy as is judged can be maintained. Old-growth stands are likely to have too many large overmature trees, while second-growth stands may have few if any trees that have reached the diameter range which corresponds to rotation age. The selected stands should be classified by sites and sampled to determine species, number of trees, and gross and net volumes. Stock and stand tables may be prepared from the samples. Increment borings should be made to determine current periodic growth. The goals of desired growing stock then may be fixed by types and sites, subject to adjustment as more accurate stocking and growth data become available in the future.

The desired growing stock for a selection forest may represent a lesser percentage of the normal growing stock (derived from summation of even-aged normal yields as discussed above) than in the case of an even-aged forest. If satisfactory growth rates are to be maintained and mortality is to be minimized, tree-selection silviculture requires short cutting cycles and therefore light cuts. This means that all parts of the forest will be disturbed at frequent intervals. More logging damage may be done to the reserve stand, since the frequent harvest cuts commonly will remove mature, relatively large-crowned, trees. The intimate mixture of trees of all age classes may cause considerably more competition than is experienced in even-aged management, thus growth rates may be slower. When individual mature trees are removed, abundant reproduction may come up in the small openings and may reduce the growth of the older elements of the stand, particularly in areas where soil moisture is a limiting factor.

If actual cutting practice tends to remove groups of two or more trees, then the silvicultural system becomes group selection, which is a form of even-aged management. Actually group selection is far more prevalent, practicable, and desirable than tree selection for

many forest types. When the group selection system is used, normal growing stock may be derived by the summation method, as with other forms of even-aged management.

Application of Growing Stock Goals

Figures for the desired growing stock for the working circle, by types, sites, and age classes in even-aged silviculture, are useful in regulation, the development of marking guides, and designating or marking timber for cutting.

Regulation is "a branch of forestry concerned with the technical aspects of organizing and maintaining a forest for sustained yield" (*4*). Clearly implied is the need to recognize not only the timber now standing on the working circle and the rate at which it grows, but also the volume which must be carried, by age classes, in order to insure sustained production at the highest practicable level. Regulation starts with present growing stock, establishes desired growing stock, and prescribes measures which will result in attaining that desired level and thereby reach and maintain sustained yield.

The management planner must have a clear conception of these facts and values. On every working circle the growing stock must be either (*1*) built up or (*2*) reduced to the desired level. Not the least difficult decision to be made is the rate of increase or decrease, bearing in mind that it is desirable to avoid abrupt changes. There are many factors to be evaluated. In an understocked working circle consisting of young, growing stands, a high percentage of the calculated growth may be accumulated each year.[5] Many of the stands, however, will need intermediate cuts to avoid local overstocking. Disease or insect losses may dictate heavier cuts in some stands, and other factors may make it necessary to progress more slowly toward the goal of desired growing stock than at first would seem desirable. The following example shows how prescriptions of an actual management plan will result in progress toward desired growing stock during a 10-year cutting cycle.

Analysis of the planned management of the timber resource, Davy Crockett National Forest, Texas.—This analysis, prepared by A. J. Streinz, Division of Timber Management, U. S. Forest Service, Atlanta, Georgia, is based on the timber management plan for the period July 1, 1946—June 30, 1956. The commercial forest land totals 158,668 acres, of which 6,588 acres are bottomland hardwoods, 69,824 are pine (mostly shortleaf) in the Neches Block, and 82,256 are pine (mostly loblolly) in the Trinity Block. Only pine growing stock, 5 inches d.b.h. and larger, is being considered.

Desired growing stock was calculated by using 50 percent of normal stocking for a regulated forest. Summation of normal yield table loblolly pine, site index 90, and rotation of 80 years gives growing stock of 52 cords per acre; 50 percent of 52 cords equals 26 cords. Summation of normal yield table shortleaf pine, site index 70, and rotation of 100 years gives growing stock of 54 cords per acre; 50 percent of 54 cords equals 27 cords. Desired growing stock for the two blocks is as follows:

	Per acre	Total
	Cords	*Cords*
Neches	26	1,815,424
Trinity	27	2,220,912
		4,036,336

The average desired growing stock per acre for the entire area is 25.4 cords. Volume calculations for the accretion to growing stock over the 10-year period are given in Table 2. From these calculations we get the following relations:

		Percent
Growth added annually to growing stock =	$\frac{94{,}840}{147{,}040} \times 100 =$	64
Annual increase to growing stock =	$\frac{94{,}840}{2{,}158{,}400} \times 100 =$	4.4
Growing stock at end of period to growing stock goal =	$\frac{19.6}{25.4} \times 100 =$	77
Growing stock at beginning of period to growing stock goal =	$\frac{13.6}{25.4} \times 100 =$	54
Approach to growing stock goal for decade =		23

The foregoing example illustrates the rapid progress that can be made toward desired growing stock in a working circle which is stocked with young, rapidly growing timber and where it is possible to allocate a high proportion (about two-thirds in this case) of growth to accretion of growing stock. The desired level of pine growing stock in this case was set at 50 percent of normal yield table values. Experience, including the remeasurement of permanent growth and mortality plots, may show that the goal

TABLE 2.—CALCULATED INCREASE IN PINE GROWING STOCK VOLUME ON THE DAVY CROCKETT NATIONAL FOREST, TEXAS, FOR THE 10-YEAR PERIOD 7/1/46—6/30/56

Item	Trees 5.0-10.9 inches d.b.h.		Trees 11.0 inches and up			
	Total	Per acre	Total	Per acre	Total	Per acre
	Cords					
Present growing stock	1,027,400	6.5	1,131,000	7.1	2,158,400	13.6
Periodic annual increment	75,500	.48	71,540	.45	147,040	.93
Allowable annual cut	18,000	.11	34,200	.22	52,200	.33
Annual accretion to growing stock	57,500	.37	37,340	.23	94,840	.60
Periodic accretion to growing stock	575,000	3.7	373,400	2.3	948,400	6.0
Growing stock at end of period	1,602,400	10.2	1,504,400	9.4	3,106,800	19.6

should be higher. If so, new goals and revised prescriptions for attaining them can be incorporated in future revisions of the management plan. Pending such determinations, the manager of the working circle has a very definite objective for operations under the management plan during the current decade.

It should be noted that the planned management of the Davy Crockett, as analyzed above, is designed to raise in one decade the pole-timber growing stock from 6.5 to 10.2 cords per acre; whereas during the same period the saw-timber growing stock increases only from the equivalent of 7.1 to 9.4 cords per acre. The analysis is not complete because the desired growing stock figure is shown only as a total, that is, 25.4 cords per average acre. The calculation of desired growing stock should be split into the two classes which are recognized in present stock and in increment. Without this guide it is possible that the planned cut in either segment of the growing stock is too large or too small.

The goal of desired growing stock should be reflected in the development of marking guides or marking rules. In many working circles it will be necessary to increase the percentage of more desirable species, to delay or reduce cutting in some age classes, or to take other measures designed to develop the growing stock along desired lines.

A marking guide or marking rule is not an exact formula. The timber marker must interpret and apply the guide to each stand that he encounters. To do this intelligently and effectively he must understand the objectives of management. He should be more concerned with the "leave" stand than with the "cut" stand. Not only the timber cut during the year but also the timber standing on the working circle at the end of the year determine the progress being made toward sustained yield.

Normal Distribution of Growing Stock

The preceding discussion deals almost exclusively with the volume of growing stock. The area occupied by the various age classes is equally important. Normal volumes and yields are not attainable under the intensity of management which may be practicable, and lower values therefore may be fixed as goals. As to area, however, in even-aged management, normal distribution of age classes is necessary for sustained yield at any level of productivity and should be established as the goal. See Chapman's discussion of Normal Series of Age Classes (*1*), pp. 338-342 and Matthew's Chapter VI (*3*).

If site quality has not been mapped or if the boundaries between sites are not readily determined, the average site index for each type should be determined and used. If age and height determinations are made on sample trees during the inventory, height over age curves can be drawn by types. The average site index for each type then may be read from the appropriate curve. Care must be taken to measure heights as was done in preparing the site index curves in the yield table and to read the curve at the age specified in the table, usually 100 or 50 years.

The rotation is divided by the number of years in equal age classes to determine the number of age classes, or management periods. The area of commercial forest land in the working circle is divided equally into the same number of parts. Thus in a 110-acre forest of Douglas-fir, average site index 140, managed on a rotation of 110 years, normal distribution would be 11 age classes of 10 years each, and the area would be divided into 11 parts of 10 acres each.

If site quality has been mapped, differences in productivity due to site quality should be examined to determine whether an equal acreage distribution will produce satisfactory results. This can be done by listing the areas and yields at *R* years by site qualities, and calculating the average normal yield.

In the theoretical 110-acre Douglas-fir forest, managed on a 110-year rotation, the distribution of site qualities is assumed (Table 3). The weighted average normal yield at rotation age is 57.3 MBM, although there is wide variation in the yield by sites. If a normal distribution of 10-year age classes could be developed with exactly the same percentage distribution of sites in each age class area as occurs on the whole forest, there would be 10 acres in each age class. This distribution is impracticable of attainment and therefore cannot be established as the goal.

The weighted average normal yield of 57.3 MBM per acre may be used in calculating the acreage distribution which should be sought as an attainable goal. That is to say, the number of acres in each age class as developed through management should be adjusted so that the normal yield per 10-year cutting period would be 573 MBM (57.3 MBM times 10 acres). The first step is the determination of area factors by site quality which will be applied to the budgeted areas.

The area factor times 10 (normal acres in each age class) equals the area of any site index needed to produce the weighted average normal yield of 573 MBM per decade. Thus 30.20 acres of site index 90 are needed, as compared to 5.80 acres of site index 170.

Progress can be made toward

TABLE 3.—DISTRIBUTION OF SITE QUALITIES, YIELD[1], AND AREA FACTORS FOR A THEORETICAL 110-ACRE DOUGLAS-FIR FOREST

Site Index	Area		Yield per acre at *R* years	Total yield at *R* years	Area factor[2]
	Acres	*Percent*	*MBM*	*MBM*	
90	11	10	18.9	208	3.02
110	33	30	36.3	1,198	1.57
140	55	50	69.4	3,817	.83
170	11	10	98.3	1,081	.58
Total	110	100	—	6,304	—

[1]Normal yields (Scribner) are from table 4, U. S. Dept. Agric. Tech. Bul. 201.
[2]Multiplier which will provide average yield at *R* years. This is the weighted average yield, 57.3 MBM, divided by the yield at *R* years for each site index.

normal distribution of age classes by using these area factors in developing cutting budgets.

Example 1.—Budgeted area is all site index 140.
Calculation: 10 acres times 0.83 equals 8.3 acres budgeted.
Proof: 8.3 acres times 69.4 MBM equals 576 MBM.
Example 2.—Budgeted area is all of site index 90, plus site index 110.
Calculation: 11 acres site index 90 times 3.02 equals 30.2 acres, but since there are only 11 acres available it is not possible to budget 30.2 acres. Therefore, 11 acres times 18.9 MBM equals 208 MBM. In terms of average yield, 208 MBM divided by 57.3 MBM equals 3.63 acres.
The 11 acres of site index 90 is therefore equivalent to 3.63 average acres.
10 acres minus 3.63 acres equals 6.37 average acres to be budgeted in site index 110. 6.37 acres times 1.57 equals 10 acres of site 110 to be budgeted.
Proof: 11 acres site index 90 times 18.9 MBM = 208 MBM
10 acres site index 110 times 36.3 MBM = 363 MBM
21 acres budgeted has normal yield of 571 MBM

In a management plan the allocation of areas to annual or periodic cutting budgets is governed by such factors as the need for harvesting equal volumes each year, the relative thrift or decadence of stands, existing and needed transportation. When site quality has been determined for the various stands, the use of the procedure described above will aid in progress toward a normal distribution of age classes.

The significance of these calculations is apparent when applied to an actual working circle of 100,000 acres or more with site qualities represented by the percentages used in the example. When there are material variations in yield between the site qualities which occur on the area and each site quality covers several thousand acres, there cannot be satisfactory progress toward a normal distribution of age classes unless the relative productive capacity of each site is given its proper weight in the regulation calculations.

The method of making the adjustments illustrated above uses the full normal yield table values. The results would be in the same proportions if a discounted value (50 to 80 percent of normal) were applied to normal yields for all sites, as discussed above, in connection with establishment of goals of desired growing stock.

Summary and Recommendations

1. The importance of forest growing stock is not always realized in connection with management planning.

2. Growing stock should be expressed in volume of products which are marketable from the working circle. Board-foot volume should be used ordinarily, but where small-size material is marketable for pulpwood and larger sizes for saw-timber, cubic-foot volume is desirable.

3. Normal growing stock should be calculated from normal yield tables. Weighted average site quality may be used, or, if sites are mapped, the calculation should be made by site qualities present in the working circle.

4. Desired growing stock should be established as a goal of management. This may be done by establishing as the goal an attainable percentage of normal growing stock, by sites.

5. In addition to establishing a volume goal, regulation of even-aged working circles must be directed toward a normal distribution of age classes. A method of determining the acreage of each site quality that should be occupied by each age class in order to attain normal distribution is discussed.

6. An objective of management is continuity and regularity of yield. Changes in volume harvested from year to year are inevitable, but in management planning it is desirable to provide for gradual increases or decreases. Thus it seldom will be possible to reach either the goal of desired growing stock or the goal of normal distribution of age classes during the first rotation under management. Those goals are necessary to sustained yield. They should be established in the management plan, and the prescriptions of the plan should be written and carried out in a manner which will insure the best practicable progress toward both goals.

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Decay — A Problem in the Future Management of Grand Fir

Ernest E. Hubert[1]

THE SPEED at which the secondary species are moving into the front ranks of utilization makes it necessary for foresters to revaluate the future of grand fir in the western white pine type. It is evident that western white pine should be grown and protected on as many acres as practical, since it is a high value species. However, the factors of accessibility, costs of fire, blister rust and insect protection, and poor growth sites may limit the acreage which can be held over to continuous white pine production. What will be the species mixtures on areas containing little or no white pine? Will these areas contain timber of economic value? Planning now in anticipation of the need to keep these areas in continuous production of the more valuable secondary species would appear to be timely.

Of the secondary species, grand fir, *Abies grandis* (Doug.) Lind., has many desirable characteristics among which are its rapid growth, ability to reproduce under varied conditions and sites, and its existing high volume—third among the species of the type. It is a fast-growing, tolerant tree producing wide-ringed, light colored wood useful for lumber and for pulp. It is widely distributed throughout the western white pine type reaching up to elevations of 7,000 feet and is rarely found in pure stands. It does not prune its lower branches rapidly and is therefore subject to serious heart rot at an early age. Sporophores of the principal decay-producing fungus often appear at an early age and in large numbers.

Heart Rots and Root Rots

The heartwood of grand fir is attacked by a number of fungi the most destructive of which is the Indian paint fungus (*Echinodontium tinctorum* [Ell.] Ell. and Ev.,) which produces a brown stringy rot often extending the full length of the merchantable trunk. In its early stage it is difficult to detect and unlike some of the white rots, can not be used for various types of pulp. As a result it is not always kept out of pulp chips where it may affect the yield and the product or out of freshly cut lumber which when seasoned develops serious splitting and warping due to decay in the heartwood. The low yield of sound wood for pulp and the cost of transporting defective logs to the mill is a serious problem in heartrotted stands.

Of the root rot fungi attacking living grand fir, *Poria weirii* Murr. producing a yellow laminated rot in the roots and lower trunk, and *Armillaria mellea* (Vahl) Quel. attacking the roots, are perhaps the most important. *Poria subacida* (Pk.) Sacc. and *Fomes annosus* (Fr.) Cke. are found attacking the roots and develop white pocket rots which extend into the lower trunk. *Poria weirii* has been found to attack and kill young stands of Douglas-fir in western Washington, Oregon, and British Columbia. Similar parasitic attacks have not been noted in northern Idaho. It is believed that in earlier days the laminated rot of *P. weirii* was not recognized as such in grand fir and therefore was included in the brown stringy rot caused by the Indian Paint fungus. An easy method of separating the two rots (*1*) has recently been put to practical use in the forest.

To the volume loss due to decay on any grand fir site must be added the mortality loss caused by such fungi as *A. mellea* in killing the trees, and losses by windfall and windbreakage caused by *F. annosus* and *P. subacida*.

The Problem

For many years grand fir has been considered a secondary species primarily because of its susceptibility to decay. Heartrot extending from root crown to the top log in the trunk has been a common occurrence in older trees and also in young trees growing in crowded stands and on poor sites. At times it may be found only in lower, middle, or upper trunk.

To provide for future pulp and saw logs on areas where white pine can not be grown, forest management must develop a method of growing young stands of grand fir relatively free of decay until they reach commercial size. This would require harvesting the stand before decay becomes a commercial factor and before fruiting bodies are produced. To accomplish this either a cutting age or a cutting diameter may be determined by field studies based on pathological and other data. This would seek to establish the relation between decay and age or between decay and tree diameter.

In the Lake States, balsam fir produces merchantable pulpwood at 70 years (*3*). These studies have shown that the highest periodic increment is reached at a diameter of 9 to 10 inches or an average age of 90 years. Since decay becomes an important factor when the tree reaches a diameter of 8 to 9 inches, the age at this size, or 80 years, represents the pathological cutting age. Beyond this age the decay increment increases and the merchantable volume decreases. The cutting age of balsam fir in eastern Canada based on the net periodic increment is between 60 and 90 years (*4*) and for white fir in southern Oregon it is 150 years (*5*).

Figures for the establishment of a pathological rotation for grand fir are not available. However, it is known that the decay factor in some stands of the Coeur d'Alene National Forest is high, approaching that found in western hemlock. Studies made on the latter species indicate a pathological cutting age of about 80 years (*8*). If cutting grand fir stands at 80 to 90 years would yield merchantable pulp and

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saw logs, then cutting regulations, sanitation measures and even pruning might conceivably be used to reduce the incidence of infection, raise the rotation age and so produce future stands with less decay. If management methods can reduce heartrot in this species so that a pathological rotation of 100 or 110 years can be used it would provide logs of commercial size at harvest.

Grand fir reproduction would be heavy on such cut-over areas, and these areas would contain many old, defective trees loaded with conks of the Indian paint fungus. The young stand which forms heartwood at 15 to 40 years would be subjected to early infection by spores from these conks as dead branches and other openings developed in the bark, and as the trees matured the stand would become increasingly defective. The disposal of old, defective grand firs, therefore, would become one of the important steps toward a healthier and sounder residual stand and a step toward a longer rotation.

Disposal of Defective Trees

If, by simply felling these trees we could expect to eliminate further conk production and thereby cut off the spore supply, the cost of felling might not be too great to bear. However, the live fruiting bodies of the Indian paint fungus growing on the standing tree will continue to develop and produce spores when the trunk is felled to the ground. Under such conditions the spore spread would be somewhat reduced but the threat would remain since the spore-bearing surface of the new conk soon forms at right angles to the old, along the prostrate trunk, and the conks may remain alive as long as food and moisture conditions remain favorable.

Some hope that chemical poisoning of trees to loosen their bark would also poison the conks along the trunk was dimmed when such conks were tested for viability. As a part of the chemical debarking study carried out by C. F. Sutherland, Potlatch Forests. Inc. in the Clearwater area (*6*), young conks collected the year following death of the trees were cultured in the forest pathology laboratory of the College of Forestry and all proved alive. It was reasoned that little if any of the poison entered the heartwood of branch stubs to which the conks were attached since the poison moves in the bark and outer sapwood of the tree. However, all conks collected from poisoned trees dead for two or more years were found to be without life. It might be assumed that the poison had finally reached the conks, but it is more likely that the rapid drying of these trees due to loosening and shedding of bark dried the rotted wood supplying the conks sufficiently to cause their death. Other methods of girdling should be tested for effectiveness.

The Indian paint fungus thrives under high moisture conditions. The rate of drying as well as the length of the period during which drying occurs affects its activity and therefore the production of sporophore tissue. A study of cut-over and uncut areas brought out the fact that total number of infected trees, live sporophores and sporophore-bearing trees of western hemlock and grand fir was less on cut-over than on uncut areas. This was traced to reduced shade moisture (*7*). Whether poisoning the conk-laden defective trees, allowing them to dry out for two or more years and then felling them would remove the threat of new conks is not known. Felling these trees at the time of logging without the use of chemicals, bucking the trunk into lengths and rolling alternate sections out of line to increase the drying should be tested for conk control. The drying rate would be greatest following logging when overhead shade is reduced and undergrowth is at a minimum. The merchantable logs from such trees should be utilized if costs permit.

Clearcutting and prescribed burning as a sanitation measure would have some merit but would require planting the area unless reseeding from the sides is assured.

Young, unmerchantable grand fir and other species left after logging would be sacrificed.

The question is often asked, will defective grand fir left as seed trees produce a stand which is more susceptible to heart rots and root rots than one grown from seed produced by a decay-free tree? Since it is generally believed that entrance of heart rot fungi is through injuries and dead branches there appears to be little reason to believe in the transmission of decay susceptibility through seed. It is quite possible, however, that anatomical characteristics may be transmitted which present weak barriers to the entrance of fungi into the heartwood.

Protection of Residual Trees

The main objective in disposing of defective, conk-bearing trees is to reduce the incidence of infection and so develop a means of protecting the residual trees. To be most effective this protective operation should cover an entire watershed so that a study can be made of the spread limits of fungus spores from the bordering infected stands. Studies made in other forest regions have indicated that the amount of infection in residual trees can be reduced greatly by protecting them against injuries of all kinds during the logging and brush disposal operations. Another protective measure may be found in the pruning of lower branches to prevent the formation of dead branch stubs considered to be one of the principal entrance points for heart-rot fungi. Such pruning will also result in an appreciable reduction of knot wood in the products when harvested. Some method of girdling and allowing the defective tree to dry out on the stump should be tried as well as felling defective trees and segmenting the trunks to encourage rapid drying.

Protection of the residual trees against root rot infection must also be considered since these diseases can cause serious damage in a young stand. Practical methods of control of root rots have never been developed for large forest areas and these diseases are restricted by natural influences only.

If it were practicable to uproot

the entire tree by the use of cables and bulldozers the spread of root rots by way of infected roots could be checked to a great extent. The upturned, infected root system would dry out rapidly, infection would be halted and a high percentage of the spread to nearby residual trees would be prevented. Although the outer ends of some of the infected roots would be broken off and left in the soil, the fungus development in these ends would be minor since the bulk of the fungus food supply would be removed. A large food supply is essential to the spread of some root rot fungi such as *A. mellea* which spreads infection by means of rhizomorphs as well as by spores. Leaving infected dead stumps and roots in the soil favors this spread by rhizomorphs.

Infected trunks could be cut into lengths and the alternate sections rolled free and merchantable trunks cut at a point near the root collar thus saving considerable footage. Some thought could be given to the utilization of the root wood for pulp chips or for wallboard fiber, for an area of upturned roots might present a problem in the partial logging of future stands. It would not be a serious problem on clear-cut areas where prescribed burning would aid in clearing the area.

Some thought should be given to the management system for grand fir which would result in the greatest volume of sound wood at harvest. Silvically this species is adapted to uneven-aged management by the selection system. This system, however, would favor the development of heart rots and would therefore fail to meet our objective. Clearcutting and burning has certain advantages from a sanitation angle and would remove conky, spore-spreading trees as well as reducing other defects such as root rots. However, such a system might present a serious problem in the regeneration of the species over the larger burned areas due to the limits of seed dispersal. It has been suggested (*9*) that a shelterwood or seed-tree system be tested for effectiveness. Under such a system the conky trees could be removed leaving enough healthy or conk free seed trees to reseed the area adequately for volume production.

Approach to a Solution

Every effort should be made to bring grand fir into more useful production since it represents the third largest volume of saw timber in northern Idaho based on an estimate of 5.7 billion board feet made in 1941 (*2*). Its increasing use for pulpwood and its good qualities favor this species on forest lands where white pine or other high value species can not be grown economically. However, the early development of decay in the tree and a high decay volume are two conditions which must be improved in future stands.

The key to the problem, therefore, is the protection of young stands and of residual trees on logged areas against fungus attack. This involves the following steps:

1. Determine the earliest age at which conks develop on the living trees and the points of decay entrance.

2. Establish a pathological rotation based on field studies.

3. Develop effective economic methods for disposal of the defective, conk-laden trees on logged or burned areas and determine the limits of spore distribution.

4. Develop effective methods for reducing root rots.

5. Tie these studies closely to the overall management of grand fir on both cut-over and burned-over areas.

In view of the increasing demand for pulp logs and the decreasing areas of high value species, it is not too early to plan for a maximum of sound grand fir in our future stands. The methods for accomplishing this depend upon planned, coordinated studies by the various forest agencies of the region.

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Cankers and Decays of Birch Associated with Two Poria Species[1]

R. P. True, E. H. Tryon, and J. F. King[2]

CONSIDERABLE DECAY has recently been observed in mature and overmature yellow birch (*Betula lutea* Michx. f.) on the Monongahela National Forest in West Virginia. Although the percentage of decayed trees in the stands containing yellow birch has not been obtained, many of the larger birches were found to be culls when logged. The only external indication of decay shown by many of these cull trees was the presence of one or more characteristic bark-covered cankers. In spite of the localized nature of these cankers, the decay associated with them usually extended throughout the merchantable length of the trees.

Such cankers are usually associated with a white rot. The affected wood is characterized by alternating zones of white and light reddish-brown wood. The white zones appear to be more prominent near the cankers, while the brown zones predominate near the extremities of the rot column.

The present study was undertaken to determine the cause and extent of decay in individual birch trees showing only these characteristic bark-covered cankers, and to learn whether trained personnel could recognize them in standing trees. A comparison of this canker-associated decay and a very similar decay caused by *Poria obliqua* (Pers.) Bres. was considered advisable.

Porias known to be important causes of decay in birch.—Campbell and Davidson (*2*) reported a decay of birch, occurring in the Adirondacks and also in Vermont and Pennsylvania associated with large bark-covered trunk cankers and caused by *Fomes igniarius* var. *laevigatus* (Fr.) Overh. This fungus is entirely resupinate and, although Overholts considers it a Fomes, he has for convenience included it among the Porias of Pennsylvania as *P. laevigata* (Frs.) Cooke (*3*). *P. laevigata* and *P. obliqua* (Pers.) Bres. are the only species of Poria of recognized importance on living birch.

Poria laevigata produces resupinate fertile sporophores, and sterile dark mycelial mats may develop on canker faces (*2*). The sporophores occur on the trunks or branches of dead standing or felled trees, and sometimes on the dead portions of standing living trees. They are borne superficially, usually on the bark, but occasionally on exposed decayed wood. They may be found near but not usually on the cankers. These conks are perennial, with tubes indistinctly stratified. The pores are quite small in diameter, averaging 6 to 8 per linear millimeter of pore surface. Sterile dark mycelial mats may occur between the bark scales or permeate and cover them on the faces of the bark-covered cankers.

The cankers have been reported chiefly on trees ranging from 18 to 30 inches, d.b.h. (*2*). They are often large, frequently irregular in shape, always bark-covered and without distinct callusing at the margins. Sterile mycelial mats are most prominent on larger cankers and on dead trees. Mats may be from ¼ to ½ inch in depth and form a hard dark checkered surface on the cankers. The decay is described as an extensive white rot.

Poria obliqua produces both sporophores and sterile conks. The sporophores are resupinate, and are formed only during the late stages of decay in dead standing trees or in logs. The sporophore forms within the decayed wood close to the cambium. The sporophores are annual and are quickly destroyed after the bark and outermost wood rings are burst open, exposing them to the attack of insects. The pores are larger than those of *P. laevigata*, there being only 3 or 4 per linear millimeter on the fruiting surface.

The sterile conks of *P. obliqua* are clinker-like in appearance and commonly develop at dead branch stubs, seams or cankers (including those formed by Nectria). These sterile conks are the most frequent and characteristic signs of decay due to *P. obliqua* in living birches and were first identified with this fungus by Campbell and Davidson (*1*). They are perennial and increase in size from year to year if the tree remains alive. Their growth ceases with the death of that part of the tree to which these conks are attached. Trees are often weakened and frequently break over at points where sterile conks are formed. The decay is an extensive white heart rot and is said to be identical in appearance with that caused by *Fomes igniarius* (*3*).

Birch cankers and decay in the Monongahela National Forest.—Detailed observations were made July 7 to July 11, 1952, on defective birches in two areas of the Monongahela National Forest in West Virginia. The first area was near the southern portion of Glade Run below Gaudineer Tower on Shaver's Mountain. The second was in the vicinity of Yocum, McGee, and Crouch's Runs on Cheat Mountain.

Sixteen living birches ranging up to 60 feet in height and from 10 to 30 inches in diameter at stump height were selected for study because they showed either the characteristic bark-covered cankers of the type considered to be associated with extensive decay (Figs. 1 and 2), or clinker-like sterile conks of *P. obliqua* (Fig. 3). These trees were felled and cut up with a power saw. The nature and extent of the associated decay and its relationship to the cankers was observed in cuts made in the trunks and branches (Figs. 4 and 5).

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Most of the trees with bark-covered cankers showed little or no additional external indication of decay. However, external indications of decay other than sterile conks and bark-covered cankers included sporophores of the two species of Poria, wounds, dead stubs, dead branches, and other types of cankers including those caused by Nectria. Sterile conks of *P. obliqua* frequently appeared at Nectria cankers (Fig. 6).

Six of the felled trees showed conspicuous sterile conks of *P. obliqua*. Five of these trees ranged from 10 to 16 inches in diameter. The other, 30 inches in diameter, had two small sterile conks still adhering to a dead stub five inches in diameter. Resupinate sporophores of *P. obliqua* developed beneath the bark of the dead stub after its removal to the laboratory. Nearly all of the bark had sloughed off of one standing dead yellow birch trunk and an extensive fruiting surface was found which was identified as that of *P. obliqua*.

Studies of the extent of decay in these trees bear out the 50 to 100 percent cull estimations of Spaulding, Hepting, and Westveld (*4*) for yellow birches showing single sterile conks of *P. obliqua*.

Eight of the felled trees contained bark-covered cankers which were found to be caused by *P. laevigata*. This fungus also caused the decay associated with them. Sterile dark mycelial mats are sometimes found on the faces of these cankers. All of the trees were found decayed throughout their merchantable length. Detailed information concerning these eight trees is given in Table 1. Five of them (numbers 1, 2, 3, 6, and 7 in Table 1) showed no external indication of decay other than the bark-covered cankers and an occasional inconspicuous sporophore on a small dead branch. Three trees, (numbers 4, 5, and 8 in the table) also with bark-covered cankers, might have been culled on the basis of more conspicuous indications of decay such as large dead stubs or branches.

A few fertile resupinate sporo-

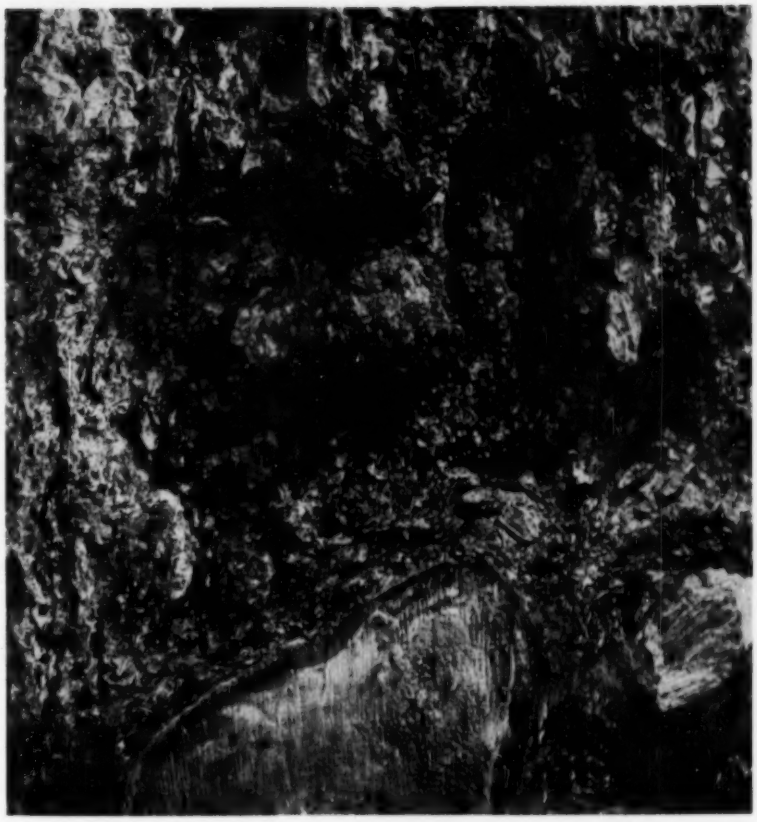

FIG. 1.—Characteristic bark-covered canker associated with extensive decay in yellow birch. These cankers and associated rot were caused by *Poria laevigata*.

FIG. 2.—A canker caused by *Poria laevigata* showing the darker bark permeated by fungus mycelium which in many cases covers the cankered area.

FIG. 3.—Clinker-like sterile conk of *Poria obliqua* on yellow birch. The sterile conks are often found at dead branch stubs, seams and associated with Nectria cankers.

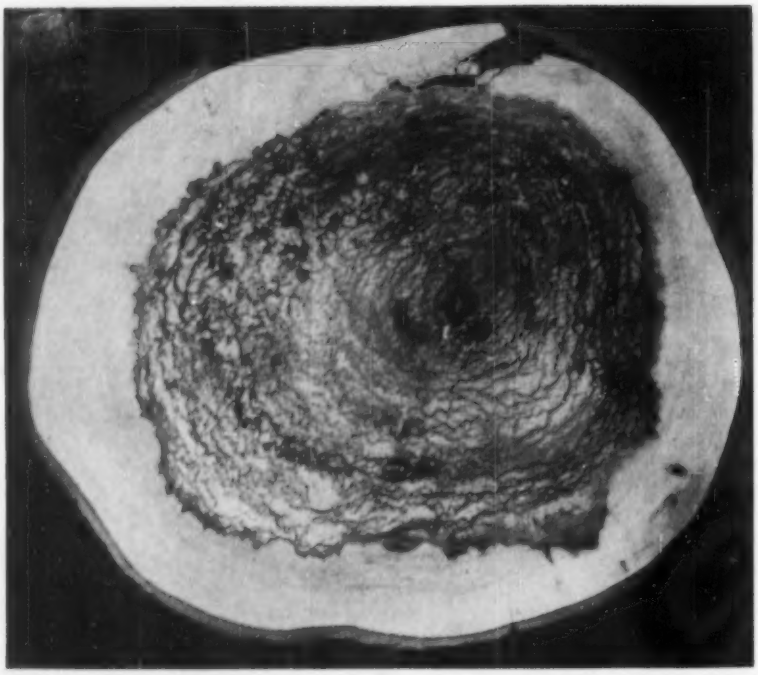

FIG. 4-A.—The pattern of advanced decay caused by *Poria laevigata* in yellow birch. The alternating zones of white and light reddish brown wood are shown.

TABLE 1.—EXTERNAL INDICATIONS ASSOCIATED WITH COMPLETE CULL RESULTING FROM DECAY BY *Poria laevigata*.[1]

Tree number	Stump diameter	Parts of tree dead	Bark-covered cankers	
			Number	Location
	Inches			*Feet above ground*
1	22	Small branches	2	9 and 12
2	24	Small branches	2	24 and 32
3	24	Small branches	4	11 and above
4	18	Small branches and dead hollow stub	1	12
5	20	Upper trunk and larger branches	1	12
6	14	None	1	12
7	20	None	2	13 and 25
8	14	Large and small branches	1	9

[1]Trees number 1, 2, 3, and 5 either produced fruit bodies of *P. laevigata* or yielded *P. laevigata* when cultured. Other trees were similarly diagnosed on the basis of the characteristic cankers. Characteristic bark-covered cankers were found only in association with complete cull. No sterile conks were found on these trees.

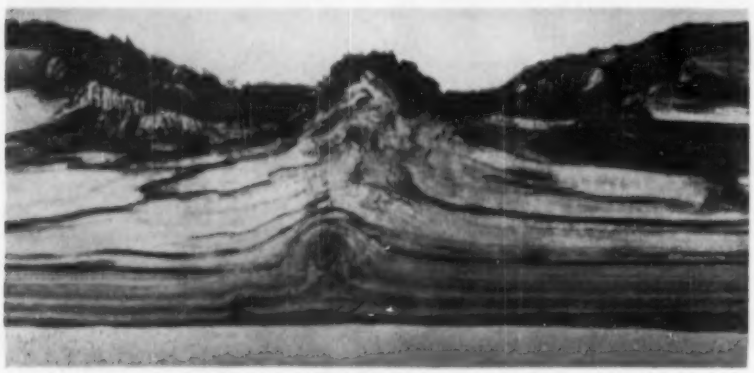

FIG. 4-B.—A longitudinal section through a canker caused by *Poria laevigata* on yellow birch. The association of the decay with the canker is shown. A branch stub is present at the center of the canker.

phores of *P. laevigata*[2] were found in the course of the examination of two cankered trees felled. They were growing superficially on the outside of the bark of dead branches of the living trees and on dead branch stubs. In one case a resupinate fertile fruiting body of *P. laevigata* was found on the exposed dead wood at the base of a tree where a very old fire scar had partially healed over. In two cases a dark coal-like appearance of the bark was noted on the face of the cankers (Fig. 2) probably the "hard, checkered surface" reported as often being characteristic of cankers caused by *P. laevigata* (*2*). Sporophores were never found on or near bark-covered cankers on living trees. Lowermost bark-covered cankers caused by *P. laevigata* ranged from 9 to 24 feet above the ground and their average height was 13 feet. The height of the lowermost cankers is an important factor in determining the ease with which trees bearing cankers caused by *P. laevigata* may be recognized.

In addition to the six trees decayed by *Poria obliqua* and the eight decayed by *P. laevigata*, one tree with non-typical cankers was purposely felled for comparison. No decay was found in it. Another tree was selected as a probable Poria tree because of the presence of apparently typical cankers at 20 and 30 feet above the ground. This tree, however, proved to be sound when cut. When viewed after felling, the cankers were found less typical than they had appeared from the ground when the tree was standing.

This study has shown that it is usually possible for trained personnel to recognize trees decayed by *P. laevigata* from the bark-covered cankers and has substantiated the fact that the characteristic cankers are frequently the only ex-

[2]Sporophore identifications of *Poria laevigata* and *Poria obliqua* were made by Dr. Josiah L. Lowe, professor of forest botany, New York State College of Forestry, Syracuse University, Syracuse, New York. Cultures of *Poria obliqua* and *P. laevigata* were identified by Mrs. Frances Lombard of the Division of Forest Pathology, U. S. Department of Agriculture.

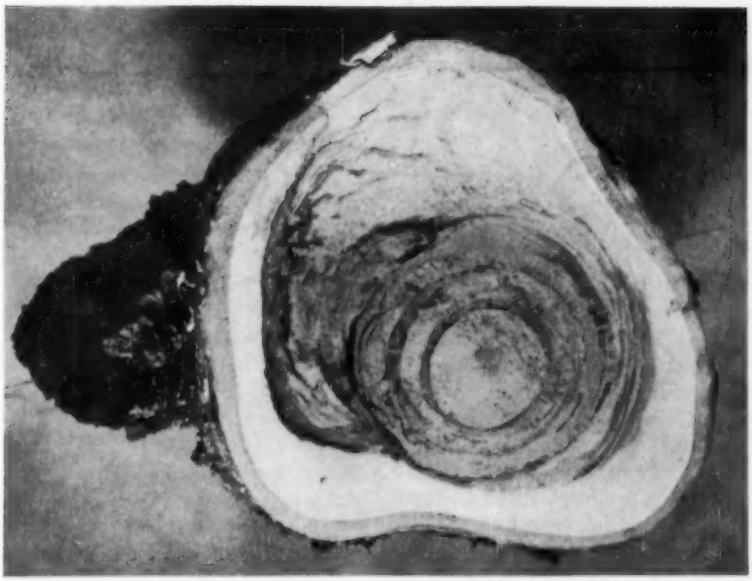

FIG. 5.—The pattern of advanced decay caused by *Poria obliqua* in yellow birch. A sterile conk of the fungus is shown attached to the log. This decay is similar in appearance to that caused by *Poria laevigata*.

ternal indication of a completely unmerchantable tree. *P. obliqua* has been found more frequently attacking trees of small diameter and, like *P. laevigata*, is responsible for considerable timber loss. Its sterile conks are reliable indications of extensive decay.

Summary

Two species of Poria were found to be causes of decay in living birches on the Monongahela National Forest in West Virginia.

One species, *P. laevigata*, may be recognized by characteristic bark-covered cankers on mature and overmature living birches. Often no other external signs of decay were found. These large bark-covered cankers indicated the presence of a white rot so extensive that affected trees examined contained no merchantable volume.

The other species, *P. obliqua*, which also causes a white rot, may be recognized by the sterile, perennial, clinker-like conks which grow out from branch stubs, seams or wounds on the trunks of affected trees. These conks are often found at target-like cankers caused by Nectria. *P. obliqua* frequently attacks living trees of small diameter, and a single clinker-like conk usually indicates extensive decay.

The conditions caused by both fungi can usually be reliably diagnosed by trained observers.

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FIG. 6.—A young sterile conk of *Poria obliqua* pushing out through a target-type Nectria canker on a small yellow birch.

Pulpwood from Small Sawmill and Logging Residues: Problems and Opportunities[1]

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A THOUSAND board feet of dressed pine lumber contains 61 cubic feet of wood. However, to obtain this volume of finished product, the lumberman must cut approximately 200 cubic feet of sound standing timber. Of the volume lost, 20 percent is left in the woods as tops and broken trees, 60 percent is in slabs, edging strips, end-trims, and sawdust at the mill site, while the remaining 20 percent is largely planer shavings. At the present level of lumber production in the Southeast, the output of solid residues alone is equivalent to 7 million cords annually. Most of these solids are suitable for pulping, and 7 million cords nearly equals the yearly cut of pulpwood in the region. However, aside from some 900 thousand cords of topwood, practically none is used for this purpose.

The feasibility of pulping residues from lumber and veneer plants has been thoroughly demonstrated in the West. In 1951, for example, about a million cords were converted to pulp. This volume was supplemented by 400 thousand cords of cull trees and other logging leftovers to fill nearly a third of the year's pulpwood requirements. Why then, do the southeastern pulpmills, which consume 70 percent more pulpwood than those in the West, salvage so little?

The chief reason is the small size of the average sawmill. Western operations are large enough to provide substantial concentrations of residues and to warrant the installation of elaborate log-barking equipment. Pulpwood chips must be bark-free for most purposes, and the smallest log barkers require a minimum daily output of 20 thousand board feet to justify their installation. There are probably not 65 sawmills in the Southeast that meet this specification, and 70 percent of our lumber is from sawmills with daily capacities of 12 thousand board feet or less. Many are portables that would be handicapped by the weight of extra machinery. Furthermore, their relative inaccessibility and frequent moves add a problem of wood assembly to that of bark removal.

These are formidable obstacles, but the potential advantages of salvaging residues are sufficient to arouse an ever-growing interest among foresters, lumbermen, and paper companies. Aside from its obvious value as a conservation measure, the pulping of sawmill residues offers specific and practical benefits to the individuals and companies involved. To the pulp companies, for instance, it offers a more stable wood source than they now enjoy, for full-time commercial sawmills operate more consistently and are less affected by weather than pulpwood crews. To sawmill operators and landowners, it offers a market for material now unsalable.

Survey of Residues

As the first step in an investigation of the economics of salvaging small sawmill residues for pulping, the Southeastern Forest Experiment Station has surveyed a typical area in the roofer lumber belt. This area was a circle of 30-mile radius centered on Delta, Union County, South Carolina, a small

[1]This article is a condensation of a longer report, "Sawmill and Logging Residues in the South Carolina Piedmont: Problems and Methods of Salvage," published as Station Paper No. 31 by the Southeastern Forest Expt. Sta., Forest Service, U. S. Dept. Agric.

FIG. 1.—This portable mill produces about 2,100 cords of pulpable residues a year.

FIG. 2.—The sawmill has moved on. Fifty-nine percent of the slabs and edgings are given away or left to rot.

rail station and siding in the Piedmont. It was selected, not only because lumbering was in active progress, but because a number of paper companies purchase large volumes of pulpwood there.

The survey showed 147 operating sawmills in the Delta area. Lumber production during 1951 totaled 81.4 million board feet, of which 66.8 million or 82 percent was pine. Construction lumber was the chief product.

There are no large sawmills in the Delta area, and many of the mills operate part time. In 1951 only 34 produced as much as a million board feet, and they accounted for 60 percent of the year's output. Most of these larger producers were portables. At the time of the survey in May, 1952, 104 timber tracts were in process of logging, and there were portable sawmills on 98 of them.

Estimating usable residue solely, we found that tops and broken trees on logging operations averaged 0.5 cords of pulpwood-size rough wood per thousand board feet of lumber produced. Chippable slabs and edging strips were being produced at a rate equivalent to 0.7 cords of rough, round pulpwood per thousand.

To gain some conception of what these ratios mean, it may be helpful to think of a typical portable sawmill operating in a typical stand of timber. The mill has a daily output of 6 thousand board feet. Therefore, logging the mill produces 3 cords of pulpable tops and broken trees every day. The chippable slabs and edging strips amount to another 4 cords. Thus, this typical operation produces as a by-product as much wood per day as the average pulpwood crew.

The 1951 output of usable residues in the Delta area was estimated at 97 thousand cords. Of the total, 41 thousand, or 42 percent, was in tops and broken trees, the remaining 56 thousand in slabs and edging strips. Mill residues did not include blocks, for no end-trimming was done at sawmills.

Accessibility

Of course, from a wood procurement standpoint, total quantities are not too meaningful. We still need to know how much is economically accessible and how much is actually available for purchase at various prices. The question of economic accessibility is a complex one. Residues which could be profitably salvaged by one operator or one method might be unprofitable for another. Nevertheless, certain factors of location and concentration of material largely determine the point of marginality for each man or method.

Slabs and edgings, piled as they are at the mill sets, require no bunching or woods travel. Also, one of the main considerations in placing a mill is to select a site from which heavy loads of lumber can be easily trucked. A site so selected is equally favorable for the removal of mill residues.

Even in the case of logging residues, location is seldom the main determinant of economic accessibility. Whether the topwood on a cut-over tract is or is not operable is more likely to depend on the concentration. Table 2 shows the volumes of residues per logging chance and per mill set in the Delta area. Even more important in the case of topwood is the volume per acre (Table 3), since it strongly influences the costs of limbing, bucking, and loading. Also significant to a prospective purchaser is the number of sawmill operators with whom he would have to deal to obtain a specified quantity each year (Table 4).

Competing Uses

So much for the physical factors of location and concentration. There is also the matter of the already existing uses for residues. In the Delta area firewood is the chief use, and slabs are favored because they are conveniently piled at easy-to-reach locations and can be readied for use with a buzz saw. Tops and broken trees are scattered and have to be worked up in the woods. Since there is more than enough slabwood to supply all needs, practically no tops are cut up for fuel. Indeed, only 14 percent of the tops on the sample tracts were salvaged for any purpose, and nearly all of them for pulpwood. By contrast, 41 percent of the slabs and edgings were used.

In appraising the possibilities for salvaging added volumes of sawmill and sawmill logging residues for pulping, it may be helpful to note the prices at which these materials have been selling. The prices in Table 5 are those that prevailed from the late spring to early winter of 1952. They are for the residues "as is" before assembling or preparation of any kind. Volumes unused or given away are considered to be valueless; volumes used as home fuel have been assigned values based on the prices reported for fuelwood sales. The resulting schedules show the approximate quantity available at each stated price. Of course, any substantial increase in demand, as by launching a large purchase program, would tend to raise prices all along the line.

Salvage Problems and Methods

Where pulpwood cutting follows logging in the Delta area, the main attraction is the residual stand. Tops and broken trees may be worked up as the standing trees are removed, but more often than

TABLE 1.—OUTPUT OF USABLE RESIDUES BY SPECIES AND CLASS OF MATERIAL, 1951

Species group	Logging residues		Mill residues	
	Cords	*Percent*	*Cords*	*Percent*
Southern pines	32,450	79.9	48,178	85.7
Yellow-poplar	3,824	9.4	3,915	7.0
Sweetgum	1,585	3.9	1,732	3.1
Other soft-textured hardwoods	519	1.3	528	.9
Oaks	1,862	4.6	1,551	2.8
Other hard-textured hardwoods	355	.9	290	.5
Total	40,595	100.0	56,194	100.0

TABLE 2.—SITES AND USABLE RESIDUES BY CLASS OF MATERIAL AND VOLUME PER SITE, MAY 1, 1952

Residues per site class	Sites		Volumes	
	LOGGING RESIDUES			
Cords	*Number*	*Percent*	*Cords*	*Percent*
Less than 25	10	9.6	137	1.3
25- 49	27	26.0	986	9.7
50- 74	22	21.2	1,297	12.8
75- 99	18	17.3	1,529	15.1
100-199	20	19.2	2,629	25.9
200-299	3	2.9	726	7.2
300 or more	4	3.8	2,846	28.0
All classes	104	100.0	10,150	100.0
	SAWMILL RESIDUES			
Less than 25	14	14.3	210	1.7
25- 49	19	19.4	669	5.3
50- 74	16	16.3	995	8.0
75- 99	15	15.3	1,290	10.3
100-199	21	21.4	3,010	24.1
200-299	5	5.1	1,221	9.8
300 or more	8	8.2	5,094	40.8
All classes	98	100.0	12,489	100.0

TABLE 3.—TIMBER TRACTS AND USABLE LOGGING RESIDUES BY VOLUME PER ACRE, MAY 1, 1952

Residue per acre class	Tracts		Total residues	
Cords	*Number*	*Percent*	*Cords*	*Percent*
Less than 0.5	10	9.6	229	2.3
0.5-0.9	29	27.9	1,394	13.7
1.0-1.4	42	40.4	4,853	47.8
1.5-1.9	15	14.4	2,157	21.3
2.0-2.4	8	7.7	1,517	14.9
All classes	104	100.0	10,150	100.0

TABLE 4.—SAWMILLS AND USABLE SAWMILL RESIDUES BY 1951 RESIDUE OUTPUT

Residue output class	Mills		Residues	
Cords	*Number*	*Percent*	*Cords*	*Percent*
Less than 100	60	40.8	2,613	4.6
100- 199	10	6.8	1,633	2.9
200- 299	11	7.5	2,874	5.1
300- 399	10	6.8	3,684	6.6
400- 499	14	9.5	7,119	12.8
500- 599	7	4.8	4,067	7.2
600- 699	7	4.8	4,932	8.8
700- 799	8	5.4	6,761	12.0
800- 899	6	4.1	5,753	10.2
900- 999	6	4.1	6,394	11.4
1,000-1,099	4	2.7	4,522	8.0
1,100-1,199	1	0.7	1,324	2.4
1,200 or more	3	2.0	4,518	8.0
All classes	147	100.0	56,194	100.0

TABLE 5.—USABLE RESIDUES AVAILABLE ANNUALLY BY PRICE AND CLASS OF MATERIAL

Price per cord	Volume available			
	Logging residues		Sawmill residues	
Dollars	*Cords*	*Percent*	*Cords*	*Percent*
0	34,900	86	36,000	64
.25	35,000	86	38,800	69
.50	35,100	86	41,000	73
.75	35,200	87	43,300	77
1.00	35,300	87	45,500	81
1.50	36,900	91	48,900	87
2.00	38,600	95	52,300	93
2.50	40,600	100	55,100	98
2.75	—	—	56,200	100

not the smaller or more scattered tops are left. Thus, although some logging residues are utilized on nearly a third of the cut-over tracts, only 14 percent of the volume is taken.

Where only tops are available for cutting, the consensus among pulpwood producers is that the operation cannot be made to pay. There is some evidence this may not always be true, but in any event the use of topwood cannot expand as long as the producers feel there is more profit in cutting standing timber. Right now, the possibility of salvaging slabs and edgings is arousing greater interest.

As previously noted, large sawmills are scarce in the Southeast. Nearly three-quarters of our lumber is produced at mills little or no larger than those around Delta, and the proportion increases every year. Therefore, if any substantial volume of sawmill residues is to be salvaged for pulping, it must be done under conditions essentially similar to those prevailing in the Delta area. The chief problems are (1) how to transport the residues economically from source to pulpmill, (2) how and where the debarking can be done most efficiently, and (3) how and where the chipping can be done most efficiently.

Slabs, as they come from the saw, do not lend themselves to economical transportation. For one thing, they are nearly 35 percent bark. This bark is almost as heavy as the wood and useful only as boiler fuel. Therefore, it should be eliminated as near the source as possible—either at the sawmill or at a rail loading point.

Also troublesome are the irregular shapes and lengths of slabs, which make them slow to load and difficult to load solidly in trucks or railroad cars. The use of specially designed pallets or steel strapping might help here, but the likeliest solution is to chip the slabs. Chips are easily loaded and unloaded by means of conveyors, impellers, or blowers at about half the cost of solid cordwood, and their weight in box cars compares favorably with the average loading of round pulp-

wood. In the West, chips are transported distances up to 70 miles by heavy truck and 200 by rail.

The price and weight of present-model log barkers appears to prohibit their installation at small sawmills. Similarly, tests by southern pulp companies seem to rule out the possibility of debarking lightweight slabs from second-growth timber in barking drums such as are used for round pulpwood. Hand peeling may be feasible in some instances at certain seasons but is generally too wasteful of labor. Among the possibilities still remaining are the "buzz barker," the hydraulic slab barker, and the "shaker aspirator."

The so-called "buzz-barker" is a small cutter-head peeler. With a 2-man crew, it can process 5 cords of slabs a day. The principal disadvantage is that it wastes about a third of the wood in the slabs. So great a loss might well be prohibitive if the slabs were purchased and transported some distance before peeling. Another disadvantage is the high labor cost, amounting to about $2.50 per cord. On the other hand, the buzz barker is inexpensive, requires little power, and is light enough for use at portable sawmills.

Hydraulic slab barkers have been operating in the West for a number of years. They do a clean job and are said to waste little wood. However, their cost and high power-and-water requirements are prohibitive except where there are great concentrations of slabs, as at a pulpmill.

More promising, in some respects, are the possibilities of removing the bark after chipping rather than before. During the peeling season, the jar of the chipper knives alone is sufficient to separate bark and wood. At other seasons, further treatment is needed. One way of separating bark from chips is by the "shaker aspiration" method.[2] The equipment for the process consists of a "drubber," screens, and aspiration hood. The chips are sized and the bark knocked loose in the drubber; the screens and hood then remove the bark and fines. In this way, all but 4 to 7 percent of pine bark is removed, and the accompanying loss of wood is only about 10 percent. Output is 4 tons of chips per hour. The size and cost of this equipment limit its use to slab concentration points.

So much for the mechanics of debarking. Apparently, devices already available make it feasible to remove bark at the source, at a pulpmill, or at an intermediate concentration point. Other equipment and methods will undoubtedly appear when there is a demand for them. Thus, it seems safe to assume that factors other than the limitations of the equipment will determine where the debarking can best be done. Such considerations as a desire to keep portable sawmill equipment weights low, the need to eliminate bark-weight before rail shipment, or the possible economies of large-scale, semiautomatic operation will more than likely dictate not only where the debarking is to be done but the type of machinery required.

Chipping is not a serious problem. Manufacturers say that force-feed chippers can produce uniform chips from odd-shaped pieces of wood only 1 foot long. Furthermore, these chippers can be made small enough and light enough to be easily portable.

None of the Delta sawmills has sufficient production to keep a chipper running. Therefore, to handle slabs currently there would have to be a central chipper installation to which whole slabs could be brought from a number of mills. Either supplementing or as an alternative to the central installation, small portable chippers might be operated in conjunction with a machine such as the shaker aspirator capable of separating chips into their bark and wood components. One or more shaker aspirators might be installed at a rail loading point. As soon as a sawmill moved from a set, a chipper would move in. Chip delivery could be by a fleet of trailers.

From experience to date, it seems evident that rough slabs from small sawmills cannot be directly substituted for round pulpwood. Certainly, they cannot be debarked by usual round-wood methods, and they probably cannot be chipped satisfactorily in existing pulpmill chippers. They also pose a somewhat different transportation problem. Consequently, whether pulp companies are able to utilize sawmill residues profitably will depend, in part, on their willingness to invest in specialized machinery and other new facilities. It will also depend on organizing a procurement system capable of purchasing and assembling slabs from a great number of scattered sawmill sets at minimum cost.

If these are the main requirements for success in salvaging sawmill residues, a most promising single solution to the whole problem would appear to be the establishment of conveniently located concentration yards equipped with debarking, chipping, and chip-loading machinery. Rough slabs could reach these yards by short haul on ordinary log or lumber trucks. The chipping operation would be susceptible to strict quality control, and the bark and fines would be eliminated prior to rail shipment. Once at the pulpmill, the chips could be introduced directly into the chip-conveyor system with a minimum of equipment or handling.

[2] Eberhardt, L. Removal of bark from chips and wood pulp. Paper Trade Jour. Vol. 135, No. 25, Dec. 19, 1952.

Effects of Simulated Overbrowsing on Small Red and White Pine Trees[1]

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THE EFFECT of various intensities of browsing, and of yearly repetition of browsing on the growth of conifers is little known. Reasonably accurate answers to this question are important both in the management of deer and the management of trees. The present tests were designed to obtain data in the relative importance of *repetition* versus *intensity* of overbrowsing by recording the related factors of production of browse, survival, growth rate, development of multiple leaders, and recovery potentials. The tests involved clipping the branches and needles of small red pine (*Pinus resinosa* Ait.) and white pine (*P. Strobus* L.) trees in a manner and at a time that might reasonably be assumed to approximate browsing by white-tail deer (*Odocoileus virginianus* Miller) or snowshoe hare (*Lepus americanus* Erxleben). Continued observations will give an indication of actual recovery to the status of acceptable crop trees.

Materials and Methods

At a transplant nursery of the Cloquet Experimental Forest in northeastern Minnesota certain beds of red and white pine transplants (2-3 stock) were not field planted in 1944 because of labor and other shortages. These trees were to be plowed under in the summer of 1945. However, as they were then about fifteen inches in height, they seemed good material for initiating a controlled experiment on overbrowsing. The stand was accordingly thinned to a spacing of 3 x 3 feet in early May of 1945 when a 9-foot fence of 1-inch mesh chicken wire was built around the area to exclude deer and hare.

The characteristics of the enclosed area can be briefly described as follows. The transplant nursery lies in compartment 7 in section 30, T49N R17W. It is an old field, nearly flat and completely open, with a stand of 40-to-50-year-old jack pine (*Pinus banksiana* Lamb.) around it at a distance of 75 yards on the south and 150 yards to the north. Some smooth crab-grass (*Digitaria ishaemum* Schreb.) Muhl. and sweet fern (*Comptonia peregrina* Coult.) grew in the area but was weeded out on several occasions. The soil here is Omega sandy loam. The white pines are on the top of a slight rise which is apparently blown sand and drier than where the red pines are situated. The fence did not appear to influence the trees as it surrounded an area considerably larger than that used in this project and had little discernable effect on sunlight and snowdrifts.

Undoubtedly the weather factors acted similarly on all the trees in each species group. The years 1947 and 1948 had somewhat less than the average precipitation of 28.5 inches at the Station headquarters about one-half mile from the location of the test trees. In 1947 the deficiency in rainfall was 3.4 inches, most of the deficiency occurring during the winter. In 1948 the annual deficiency was 1.8 inches but the shortage for the growing season was 4.4 inches. The years 1949 and 1950 were above average in precipitation. Monthly mean temperatures during the growing seasons varied but little from the 40-year mean.

Two factors of overbrowsing—*intensity* and *repetition* were to be tested in groups of trees replicated according to the suggestion of the late Dr. Forrest Immer. The red pines were grouped in sixes (three trees in two adjacent rows) but beginning each row at the north end of the plot so that there was a more or less completely random juxtaposition of groups. The white pines were grouped in fives (in one row) and a similar mixing of groups in adjacent rows was obtained. Each treatment was replicated three times. The northernmost tree in each group was marked by a loosely fitting metal strip around the base. The clipping and measuring was done prior to the beginning of each year's growing season—usually late in April just as the snow had melted from the open field but while the ground was still frozen.

The condition of all the trees was visually checked at the beginning of each experiment and the height and leader length of the second tree in each group was measured. In April, 1947, there were 234 red pine averaging 2½ feet in height with an average leader length of 3 inches. The white pine numbered 195 trees in April, 1949, with an average height of 3⅓ feet and an average leader length of 11 inches. All trees were judged to be in thrifty condition and growing well.

Clipping was done with Weise clippers having a single blade cutting against a flat surface. The intensities were designated as moderate, heavy, and severe. *Every* branch on the tree was clipped in each case. Moderate clipping removed every bud and ½ inch of the current annual growth behind it. Heavy clipping removed all the current annual growth. Severe clipping removed all the current annual growth and ½ inch of the older growth. Any portions of needles extending beyond the point of clipping the branch were also taken.

The repetition of clipping was planned on a 4-year basis. One group was to be clipped only the first year, another the first 2 years, another the first 3 years and the final group was clipped four successive years. This plan was carried through on the red pine beginning in April, 1947, while the concluding measurements were taken on May 2, 1951, so that the trees

[1]Paper No. 3058 Sci. Journal Series, Minnesota Agricultural Experiment Station, St. Paul 1, Minnesota.

clipped 4 years had one growing season (1950) for recovery. The other trees had 2, 3, and 4 seasons for recovery respectively. The timing of the white pine tests was carried out somewhat differently. The trees were clipped only two years—1949 and 1950—and final measurements were made in 1953. Thus, these trees had only 1 or 2 years' clipping and conversely 4 or 3 years for recovery. This change was made because it was obvious by 1951 that the clipping was too severe.

The measurements were obtained as follows. Materials removed from the groups of trees were placed in paper bags, allowed to air dry at room temperature for 24 hours and weighed to the nearest tenth of a gram. The height and length of leader produced the previous growing season was measured in feet and tenths for each tree. The number of leaders developing were counted directly in the field and, where more than one, the longest leader measured. Data presented graphically represent the average for all living trees in each category.

The uniformity of application of these procedures to the red pine was tested in two ways. Analysis of variance was computed on the weights of the clippings for the 1947 and 1948 populations to ascertain if the three replications were being clipped at similar intensities. These analyses were not carried out for 1949 to 1950 as the sample size became too small for proper statistical treatment. The heights of the trees as measured on May 2, 1951, were analyzed in a similar fashion. These two analyses indicated that the experimental procedure was not biased. Similar statistical analyses were not considered necessary for the white pine.

The question of recovery was surveyed on May 3-5, 1953, when measurements of height, leader length, and the occurrence of multiple leaders were recorded. The opinion of Dr. Schantz-Hansen and Professor Arthur Schneider of the University of Minnesota and Galen Pike of the U. S. Forest Service as to recovery possibilities was fully discussed. It is planned to examine and measure the trees at 5-year intervals to follow through this phase of the project.

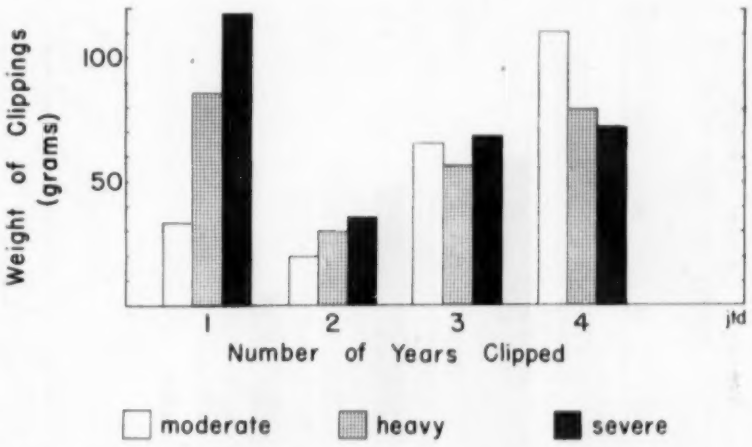

FIG. 1.—Average weight of materials clipped from one red pine, by years.

Results

The results may best be outlined separately for the two species of trees as their reactions to the treatment varied tremendously. These data are presented both from the standpoint of intensity and repetition but because the latter appeared more important, this phase is stressed in the presentation.

Red pine.—The survival of the red pine was surprisingly high. During the course of the clipping seven trees died (control — one, moderate 2 years—one, moderate 3 years—two, and severe 4 years—three). From these data it appears that the death of five trees of the eighteen most severely clipped both as to intensity and repetition was the only important loss figure. The other losses are scattered at random in the controls and the groups clipped the least.

The average weight clipped each year varied considerably, showing first a drop and then considerable recovery (Fig. 1). The recoveries, and indeed increases in weights removed, appeared to be the result of the 3 to 14 adventitious buds that developed just below the site of each cut. In May 1951, the average number of such living buds *per tree* of those clipped 4 years was 55 for the moderate, 28 for the heavy, and 15 for the severe rates of clipping. Another reason for this recovery may be that the red pine retained green needles on the stems and branches for as long as 4 years. Thus, clipping the ends did not remove all of the green needles.

The heights of living trees in 1951 showed consistent differences as between intensities of clipping and repetition of clipping (Fig. 2). The trees clipped at the moderate intensity only one year actually showed a greater height than the controls. With the increasing number of years, heights of trees clipped moderately dropped regularly but never to the initial height. The trees clipped at the heavy intensity likewise showed consistent drops with each year's clipping but were less than the average initial height at the 3- and 4-year levels. The severely clipped trees, except for those clipped only one year, were less in height than the average initial height in each case.

The length of the leaders also indicates important differences as a result of repetition of clipping, but the differences between intensities are less pronounced (Fig. 2). In no case did the growth rate equal that of the controls, although the trees clipped only one year closely approached this rate.

The possibilities of recovery and subsequent value as crop trees are of vital interest to foresters. Some indications may be derived from the data obtained on May 3, 1953. At this time all trees had at least three growing seasons for recovery

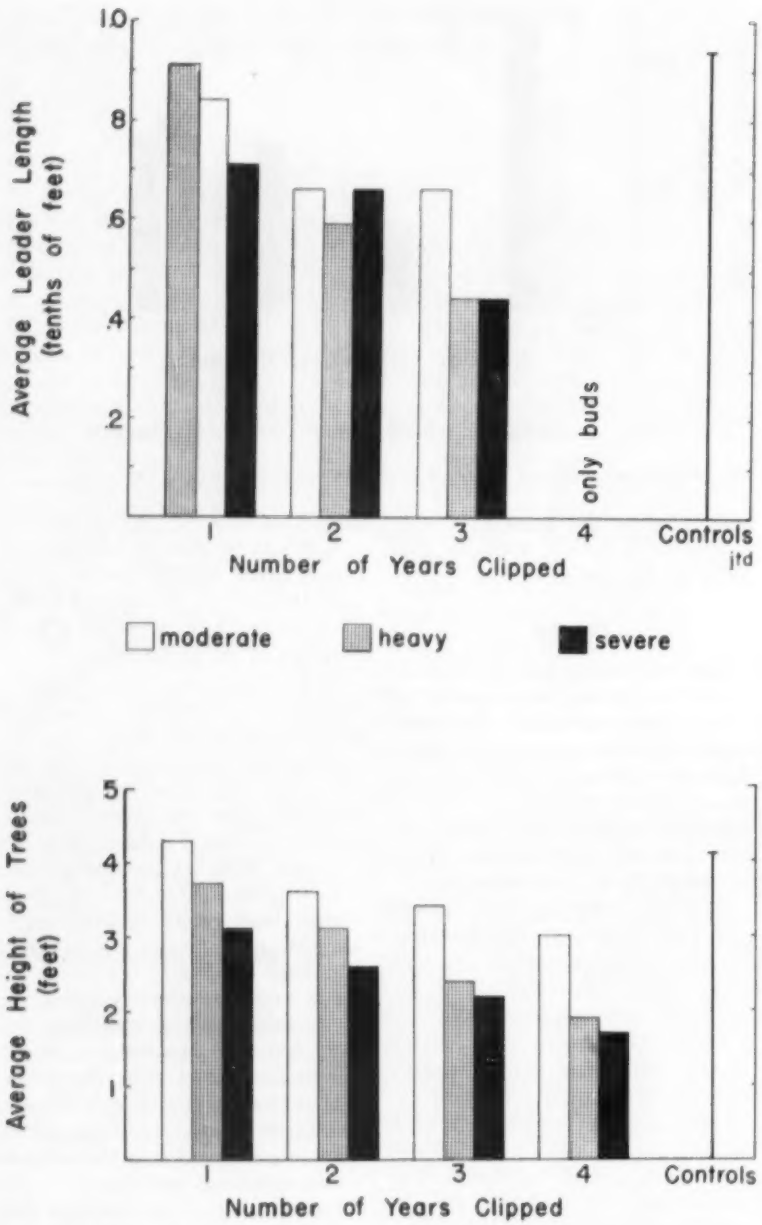

FIG. 2.—Heights and leader lengths of red pine in 1951.

TABLE 1.—RESULTS OF 1- AND 2-YEAR CLIPPING ON WHITE PINE

Intensity clipping	Repetition clipping	Trees at start	Trees dead in 1953	Trees with multiple leaders	Average height 1953	Average leader length
	Years	*Number*	*Number*	*Number*	*Feet*	*Feet*
None	—	15	0	10	6.0	0.9
Moderate	1	15	1	7	4.9	1.0
Moderate	2	45	1	40	4.0	0.5
Heavy	1	15	4	11	3.6	0.4
Heavy	2	45	34	11	2.6	0.3
Severe	1	15	1	14	3.1	0.5
Severe	2	45	45	—	—	—

while those clipped only 1 year had undergone 6 years of undisturbed growth.

The average height of living trees in 1953 (Fig. 3) again drops from year to year within each intensity of clipping. The differences between heavy and severe clipping likewise show small distinctions in the 3- and 4-year groups. Trees clipped at these two heavier rates for 4 years are still close to the initial height, but all other groups have grown at least 0.7 foot and only those clipped at moderate rate in the first year exceed the controls.

The outstanding point of the 1953 data on leader lengths is that they almost mirror the 1951 data—thus continuing to emphasize the importance of repetition.

One other concrete measurement could easily be taken in 1953. The number of leaders developing was tallied for each tree and the average number of trees with more than one leader in each group of 18 trees computed as shown in Figure 4. In the 1- and 2-year groups the intensity appeared to have some influence, as trees with more than one leader were more common at the severe rate of clipping. However, in the 3- and 4-year groups there was little difference between the intensities of clipping, and a big difference between these two year groups.

White pine.—The survival of white pine after 2 years of clipping was so low that further clipping was discontinued. However, measurements similar to those for red pine were obtained and are presented briefly in Table 1.

The trees were considered to be planted on a poor site (too sandy and dry), and both blister rust and white pine weevil damage was present in 1953.

The survival of the controls, moderately clipped trees (1 and 2 years), and the severely clipped trees (1 year) was excellent, whereas all of the trees clipped severely for two successive years died. The high mortality was thought to be a result of two factors. First, the white pine produced only a few adventitious buds after clipping and second, most needles were on the

current annual growth so that when this growth was removed, much of the chlorophyll-bearing tissues was also removed.

Other measurements taken warrant the following statements: The average weights clipped per tree were 170.4, 432.0, and 440.2 grams for the three clipping treatments in the order of their increasing intensity. In the second year these weights dropped sharply in each case to 79.5, 136.3, and 82.4 grams. The average heights in 1953 showed a decreasing order in relation to both repetition and intensity. The average leader lengths indicate that the trees clipped moderately for 1 year were growing slightly faster than the controls. For the other treatments leader lengths were about half those in the controls or less.

The pattern of multiple leader production in this test was extremely variable. This condition of poor form was common in the controls as well as in the clipped trees. However, the leaders on the controls were only two or three in number and well developed, whereas the clipped trees had five to six leaders and were very bushy in form. Their development into harvestable trees seems problematical.

This experiment may be summarized by stating that the treatments were too severe. The trees clipped moderately for 1 year were at least equalling the controls in leader length. The effects of clipping for two successive years were catastrophic when 100 percent or more of the current annual growth was removed. In the white pine, repetition of clipping seemed more significant than intensity.

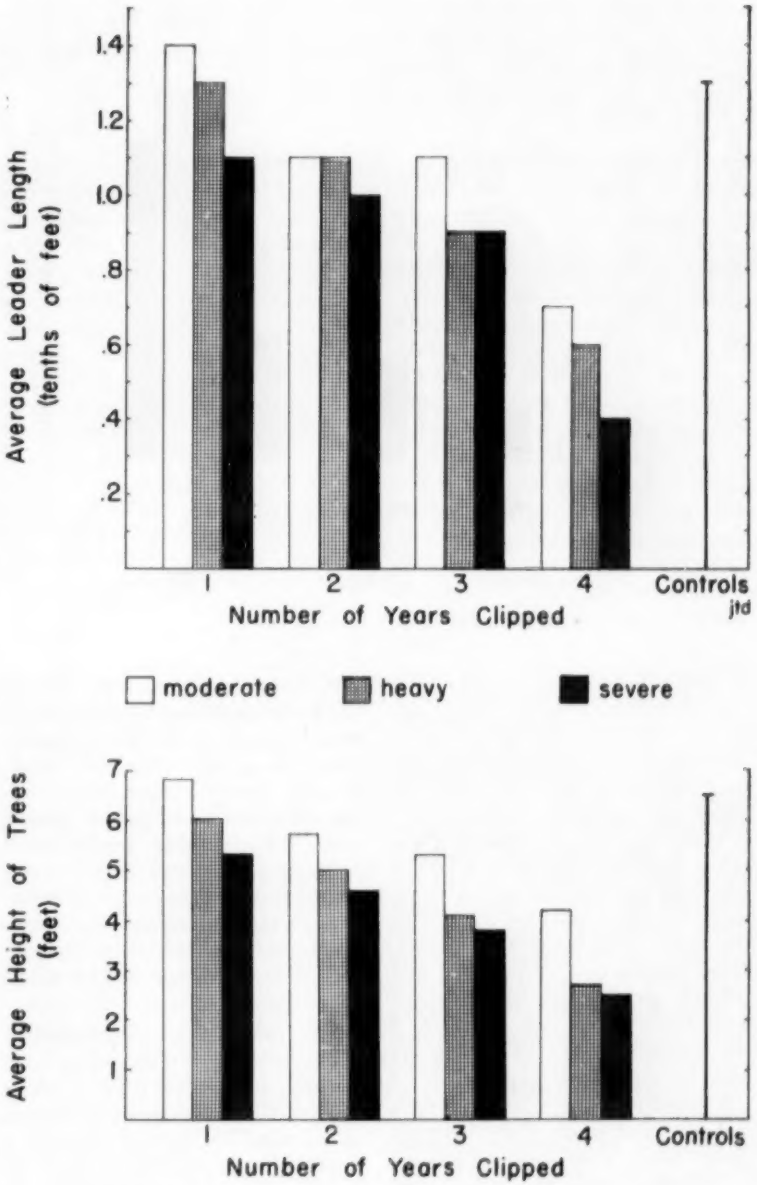

FIG. 3.—Heights and leader lengths of red pine in 1953.

Discussion

It is recognized by the writers that this experimental approach cannot be directly translated to field conditions. First, neither deer nor rabbits usually browse on *all* branches of a tree. However, in February, 1948, 4- and 5-foot-high red pine near the Brule River Ranger Station of the Wisconsin Conservation Department were noted by the senior author to be browsed at least as completely as the heavy clipping in this test while equally heavily browsed white pine were noted in other nearby yarding areas. Secondly, the trees were free from competition by other plants and survival might well be further reduced under woods conditions. Finally, let it be clear that the authors believe, with many others, that browsing by either deer or hares to the extent used here is definitely undesirable from both the forest and wildlife management viewpoint.

The project planned to find out what sets or defines the limits of overbrowsing of *well established* trees. Several points in this connection seem to be demonstrated.

Within the limits of this experiment, red pine withstood overbrowsing much better than white pine. This reaction appeared to be a function of ability to develop adventitious buds and the retention

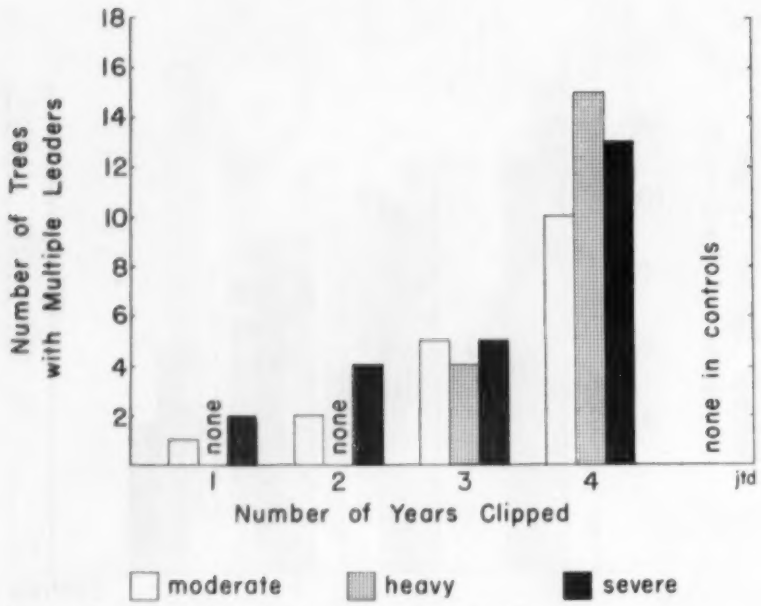

FIG. 4.—Number of red pine with multiple leaders in 1953.

of green needles on woody stems and branches 2 to 4 years old. These responses may have been a function of site quality as the red pine was on a good site and the white pine on a poor site.

This experiment differed from other recently described work of Krefting and Stoeckeler[2] in many respects. These authors dealt with "recently established tree plantations" of 2-0 and 2-1 red pine and white pine. Further they clipped only "one inch below the end of the terminal bud". Their report also indicates the importance of "frequency of clipping" in both red pine and white pine. They report "white pine is more resistant to clipping than red pine" and that "white pine is capable of producing a new leader—from an adventitious bud formed on the leader". Both these results are in direct opposition to those of this study. This may be due to the differences in site quality; to a change in the responses of the trees with increasing size; or perhaps both of these points or other unknown qualities.

[2]Krefting, Laurits W., and J. H. Stoeckeler. Effect of simulated snowshoe hare and deer damage on planted conifers in the Lake States. Jour. Wildlife Mgt. 17:487-494. 1953.

The relatively greater importance of *repetition* of overbrowsing seemed demonstrated for both species. This was reflected in survival, heights, leader lengths, and development of multiple leaders in each case. With red pine, the difference between the 3- and 4-year treatments appeared to be the place at which real and significant deterioration set in. With the white pine this occurred at the end of the 2-year treatment.

The *intensity* of overbrowsing, while resulting in differences within each year, did not show the same uniformity of differences at the end of the test. Further, 2 years later many of these differences had become masked — particularly the growth rate of the leaders.

These data are of particular interest when considering the field problems of the forester and wildlife manager. Too often, each group discusses its phase of the problem from the standpoint of extremes and battle lines are set at these points. These data indicate that 1, 2, or even 3 years of overbrowsing may be tolerated by well established conifers which can then recover in growth rate and form. It is the authors' belief that at times "deer damage" is exaggerated by persons who, observing 1 year's browsing, conclude the trees are ruined. These results place added emphasis on the necessity for action by wildlife managers to alleviate population conditions that cause overbrowsing as soon as possible, since quick action will probably permit the trees to survive and recover from the damage.

Summary

1. An experiment designed to test the effects of various intensities and yearly repetition of simulated browsing on well established red and white pines was carried out at the Cloquet Experimental Forest, Minnesota.

2. The conditions and procedures of the work are described in detail. Observations will be continued to estimate the effects on development of crop trees.

3. For the red pine: the weight of browse material clipped showed a uniformly severe drop the second year but then at the moderate and heavy intensities a recovery to at or above initial weight taken; survival was not a serious problem; reductions in average heights of trees at the end of the tests showed consistently and progressively the importance of repetition; recovery, as shown by leader lengths, showed uniform and progressive differences as regards repetition; repetition of 3 and 4 years caused increasing development of multiple leaders: finally, indications of recovery two years later mirrored the results as to the importance of repetition.

4. For the white pine: the treatments were too severe. However, the importance of repetition was again demonstrated.

5. These results are discussed in the light of previously reported work on these species and of the field problems of both the forest and wildlife manager. They indicate that short periods of even severe overbrowsing may not be ruinous to small trees and hence emphasize the importance of quick action to reduce overpopulation of browsing animals.

Soil Characteristics and the Growth of European and Japanese Larch in New York[1]

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THE EXOTIC LARCHES, *Larix decidua* and *L. leptolepis*, are being increasingly used for reforestation in northeastern United States. On favorable sites the growth of individual stems in youth greatly exceeds that of other conifers and the species appear promising for early production of pulpwood[2] (*5*) and other products (*14*).

The purpose of this study was to provide a means of estimating site index for larch from soil characteristics. Such guides have obvious usefulness in making recommendations in advance of planting, as well as in deciding on cultural measures in young plantations. The relative youthfulness of present plantations limits extrapolation of the results to mature stands. Accordingly, site index at age 25 is used as the standard throughout the paper.

The principal area of study was the southern New York State upland where numerous state and private plantations have been established on land formerly in agriculture. General descriptions of the climate and soils are given by Mordoff (*12*) and Howe (*9*). Some of the soil features affecting plantations are discussed by Stone, Morrow, and Welch (*16*).

Literature

Coile (*3*) has recently summarized the growing literature on the relationships between soil factors and the growth of trees. Physical soil classes or physical measures of site factors have been found highly correlated with site index in several areas (*4, 6, 7, 8*). In particular, indexes of soil depth or of depth to a layer restricting root development seem to be applicable to many different areas.

General accounts of the site requirements of European larch are numerous although far from precise. Day (*6*), however, working within a limited area, demonstrated through partial correlation analysis that early height growth of the European and Japanese larches was related directly to depth of free rooting material and inversely to elevation.

Procedure

Plots representing a single soil condition were established in pure or mixed plantations of larch. Border areas, and those affected by extraneous conditions such as ditches, were excluded. The requirement that the trees be growing under forest conditions eliminated several Class V sites on both excessively drained and very poorly drained soils because of low survival. The plots ranged in age from 15 to 45 years with a mean of 20 for European larch, and of 15 for the Japanese species which has come into use more recently. On each plot a pit was dug, the soil described according to standard procedure (*15*) and slope, aspect, and elevation recorded. Uniformity of depth and drainage within the plot was checked by auger borings. Thereafter diameters and heights of at least 5 dominant and codominant trees were measured, using an Abney level and tape for heights above 50 feet and an extension pole for those below (*1*). The pH of the soil was determined colorimetrically in the field, and organic matter determined by the method of Peech *et al.* (*13*) on collected samples. The latter values were restored to a field basis by correcting for the coarse fragments removed in sample preparation.

During a preliminary analysis it was found that plot values from the excessively drained soils did not conform to the curvilinear relationships indicated between site index and measures of depth and drainage class. These soils, which are characterized by coarse texture or shallowness to rock, were therefore eliminated from subsequent analysis but are included in the soil type grouping. Accordingly the statistical treatment, which is based on 45 plots of European larch and 25 of Japanese larch, does not apply to the excessively drained soils.

Eight variables were tested for relationship with site index. Depth of free rooting material was taken as depth in inches to an extremely firm or compact layer (*15*), to deep bedrock or, in the very poorly drained class, to a gleyed horizon; this depth was expressed as a common logarithm. Depth in inches to a mottled layer was similarly transformed. Internal soil drainage class was coded by assigning unit values of from 10 to 50 respectively to the five classes from *very poorly drained* to *well drained* and employing the logarithms of such values. Similarly, consistence classes (*15*) of the B horizon were assigned unit values from 1, for extremely firm, to 5 for very friable. Color of the B horizon which, within the area studied, is related to drainage, was expressed as Munsell chroma numbers from 1 to 7. Corrected organic matter content was expressed as percent, slope as percent, and elevation in feet. All of these variables were tested without transformation.

Inasmuch as preliminary plotting indicated little if any effect of texture, pH, and aspect, these latter variables were not further analyzed.

European Larch Site Index

The height-age data for European larch obtained in this study fell well above the range indicated by the British Forestry Commission curves (*2*). Accordingly, these data were pooled with other height-age values for this species in New York

[1]Based on a thesis submitted by P. L. Aird in partial fulfillment of the requirements for the M. S. degree, Cornell University, 1952.

[2]Cook, D. B. Personal correspondence, 1953.

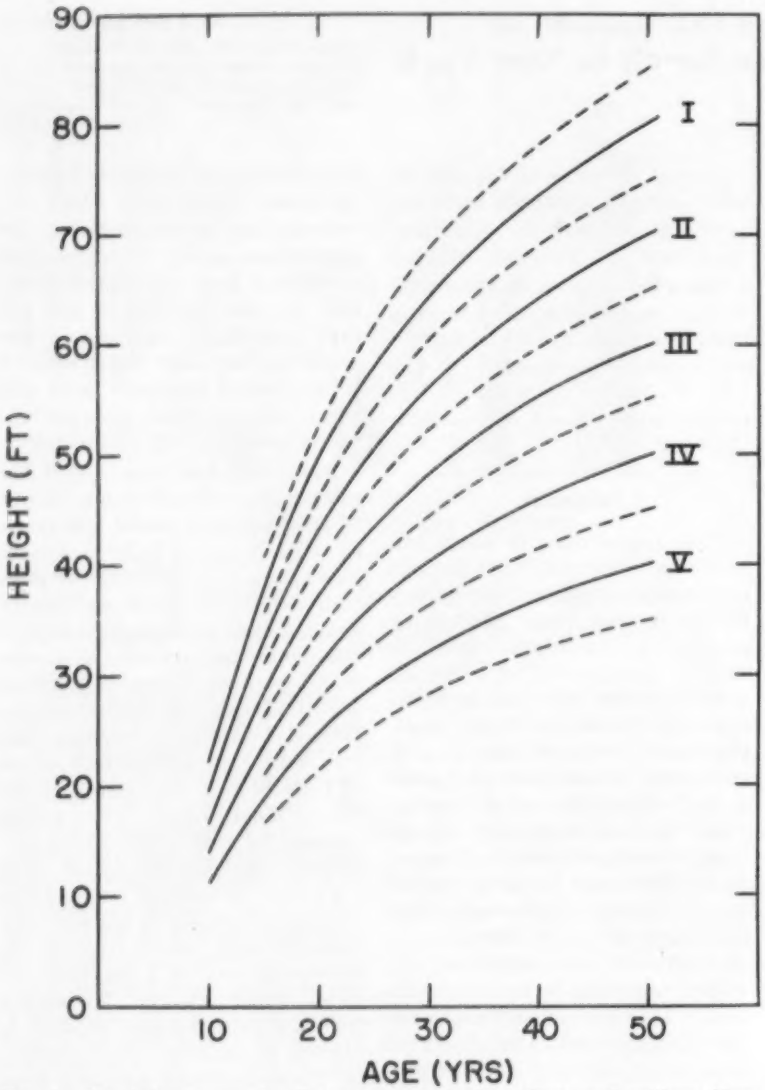

FIG. 1.—Site index curves for European larch in New York and southern New England.

and southern New England compiled from published (*11*) and unpublished[3] sources. From the total of 147 values, empirical curves were prepared by the method suggested by Schumacher (*7*). This makes use of a linear relationship between the logarithm of height and the reciprocal of age since planting. The resulting equation for site index at age 50 is:

$$\text{log site index} = \text{log height} + \frac{6.970}{\text{age}} - \frac{6.970}{50} \quad (1)$$

This equation can be modified by replacing the 50 in the denominator of the final term by any other standard age of comparison.

The resulting curves are shown in Figure 1.

This treatment was applied also to the lesser number of height-age values for Japanese larch. The resulting curves fell above, but were similar in form to those presented by Hummel (*10*); accordingly, the latter were used in computing the indicated site index in the analysis that follows.

Results

Table 1 demonstrates the degree of association between site index and the various site factors. In addition the corresponding simple regressions and the correlations between various site factors were examined. As exemplified by the European larch data in Table 2, some of the site factors are strongly correlated with the depth and drainage variates and appear to owe their association with site index to these correlations.

As a result, multiple correlation analysis reduced the residual variability only slightly. The squared coefficient of correlation (R^2) between site index, and log drainage class and log depth of free rooting material combined are .70 and .69 for the European and Japanese species, respectively. Inclusion of slope and elevation increased these values to but .71. These may be compared with the range, .62 to .67, obtained by squaring the first two pairs of values in Table 1.

Accordingly the simple regressions of site index on depth or drainage class appear more useful for site prediction. The equations:

Depth of free rooting material—

European Larch $SI_{25} = 11.64 + 29.23$ log depth (2)

Japanese Larch $SI_{25} = 28.41 + 22.16$ log depth (3)

Drainage class—

European Larch $SI_{25} = 11.69 + 26.51$ log drainage class (4)

Japanese Larch $SI_{25} = 23.91 + 23.43$ log drainage class (5)

Replacement of the logarithmic relationship of equation 2 by a second degree polynomial gave no improvement in goodness of fit.

These relationships together with the limits of the .95 confidence intervals are shown in Figures 2 and 3. Also illustrated is the comparative behavior of the two species in response to depth of free rooting material and drainage. The rates of increase seem to be only

[3]Grateful acknowledgement is made to the New York Conservation Department for data from an unpublished manuscript by S. S. Hunt (1930), to E. W. Littlefield of the same department for unpublished data, and to the Department of Forest Economics, State University of New York, College of Forestry, for data from their surveys of Broome and Lewis Counties.

slightly different for the two species, and in fact analysis of covariance indicates no significant differences between their regression coefficients with respect to depth of free rooting material, drainage or slope. The lack of such differences suggests that these site factors influence the growth of the two species in the same manner and to the same degree. Over the age range sampled, however, the species differ in absolute height with the mean site index at age 25 being 56.2 feet for Japanese larch and 47.0 feet for the European species.

As may be expected from the foregoing, growth is also readily related to soil type groups when appropriate depth separations are made. In Table 3 the soil types and phases sampled have been grouped according to drainage class and depth of free rooting material, with group means for each of the two species.

TABLE 1.—CORRELATION BETWEEN THE SITE INDEX AT AGE 25 OF EUROPEAN AND JAPANESE LARCH AND SITE FACTORS

Factors	Correlation coefficient, r	
	European larch	Japanese larch
Site Index and:		
Log depth of free rooting material	.79**	.82**
Log drainage class	.80**	.81**
Slope	.45**	.45*
Elevation	—.16	—.20
Log depth to mottling	.70**	.64**
Color of B horizon	.74**	.55**
Consistence of B horizon	.33*	.31
Organic matter content		—.16

*Significant at the 5 percent level.
**Significant at the 1 percent level.

TABLE 2.—CORRELATION BETWEEN VARIOUS SITE FACTORS, EUROPEAN LARCH PLOTS

Factors correlated	Correlation coefficient
Log drainage class with log depth of free rooting material	.82**
Slope with log depth of free rooting material	.44**
Log depth to mottling with log depth of free rooting material	.80**
Color of B horizon with log depth of free rooting material	.62**
Consistence of B horizon with log depth of free rooting material	.29

**Significant at the 1 percent level.

TABLE 3.—THE RELATION OF MEAN SITE INDEX[1] AT AGE 25 TO GROUPED SOIL TYPES

Group	European larch		Japanese larch
	Site class	SI_{25}	SI_{25}
Excessively drained			
Shallow to rock	IV	39±3[2]	—
Excessive gravel or coarse texture	III	45±4	50±5
Well drained	I	57±5	64±5
Moderately well drained	I	55±4	64±2
Imperfectly drained	II	51±5	58±4
Poorly drained			
Deeper than 15″ to compact horizon	II	47±4	—
Less than 15″ to compact horizon	III	44±5	56±4
Very poorly drained			
Deeper than 9″ to gleyed horizon	III	41±1	—
Less than 9″ to gleyed horizon	IV	36±7	46±5

[1]Averages based on 3 to 11 samples for each group and species.
[2]Standard deviation of the mean. Approximately ⅔ of the observations fall within these limits.

Discussion

The consistently greater growth of the Japanese species is in accord with the British data (*2, 10*) and American experience. The average difference, however, and the site correlations as well, disregard any influence of seed source. Some part of the unaccounted-for variability in the present study may well be due to provenance effects.

The associations between soil factors (Tables 1 and 2) reflect the kinds of sites on which the plots occurred. Well drained soils are not mottled and tend to lack compact layers which characterize many of the less well drained; they also show a greater tendency to occur on steeper slopes. Primarily because of their association with depth of free rooting material and drainage in this area, inclusion of the other factors in a multiple regression analysis does not materially improve upon the results obtained through simple regression with this depth or drainage alone. The slight increase in predictability does not warrant the additional measurements and calculations.

Inasmuch as depth of free rooting material and drainage are highly correlated (Table 2) the associated growth responses cannot be attributed simply to either. Very different moisture and aeration regimes accompany the increasing volume of free rooting material and presumably affect root activity.

From field observations it is evident that the compact or gleyed horizons which limit the "depth of free rooting material" restrict, but do not prohibit, the extension of roots to greater depths. Because of root extension below the free rooting zone and marked drainage differences within it, depth to a restricting layer may not have the same significance as depth to rock. As noted, soils shallow to rock were excluded from the sample to which Figures 2 and 3 apply. It is believed that such soils require relatively much greater depth in order to sustain the same growth rate.

There is a widespread opinion, unsubstantiated by data, that Japanese larch tolerates poor drainage conditions better than the European species. This is not borne out by their parallel responses to drainage level (Fig. 3). When the relatively constant difference between the two species is expressed as a percentage of total height, however, it necessarily diminishes with the increasing height found on better drained sites and this may, in some measure, justify the opinion.

Since much has been written about the "depleted" and "worn out" condition of the soils being

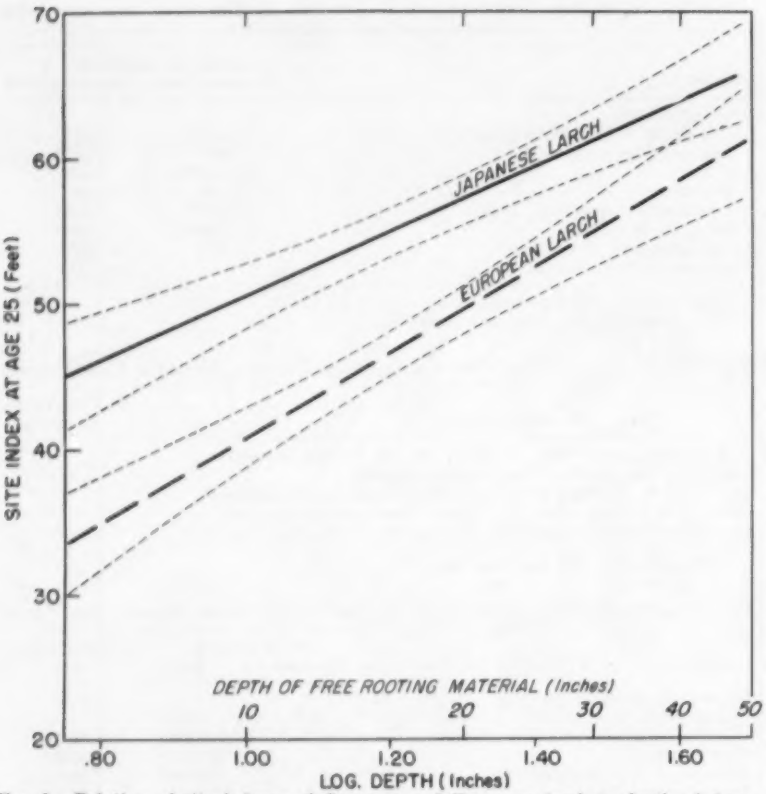

FIG. 2.—Relation of site indexes of Japanese and European larch to depth of free rooting material, with limits of the .95 confidence intervals for the regression lines.

reforested it is of interest that of the 147 plots used in compiling Figure 1, 32 percent fell in Site Classes I and II, and 64 percent in Classes I, II, III combined. As noted, however, few Class V sites were sampled in the present study because of the poor survival on such soils. Conversely, the most productive soils of the state are not represented in Table 3 since they are largely in agriculture. Accordingly a certain number of stands may be found to fall above the present Site I (Fig. 1).

The youthfulness of the population sampled necessarily restricts application of the results. There is reason to suppose, however, that the indicated differences in productivity are more likely to widen than to narrow with age.

Application

With the exception of the excessively drained sites, within the area studied the potential productivity of a site for larch can be estimated in advance of planting. Observations on drainage class or average depth to a limiting layer are easily made and the corresponding estimates of site index computed (Equations 2-5) or read from Figures 2 and 3. Depth of free rooting material and drainage class are equally reliable for average estimates of site index. Depth, however, allows finer gradation than do the five drainage classes and perhaps is more readily determined by the average worker.

The confidence intervals of Figures 2 and 3 indicate the probable positions of the true regression lines. The standard errors of estimate for a single observation based on depth or drainage lie between 9 and 15 percent of the estimated site index figure for European larch, or between 6.5 and 9.5 percent for the Japanese species.

Productivity can be estimated also from soil type groups, provided that phase separations based on depth or other important features are made, as illustrated in Table 3. Such a grouping also serves as a key to the use of modern soil survey maps. The numerous soil types of the area can be combined in a few broad groups based on similarity of growth conditions for a particular species, as elsewhere discussed (*16*).

Summary

Empirical site index curves for European larch in New York and southern New England are presented.

The relationships between the site indexes of European and Japanese larch and various soil and site features in southern New York indicated that growth is most closely related to soil drainage class, and to depth of soil above a layer restricting root development. These two soil characteristics were highly correlated with each other and with several other site factors. In consequence, multiple regression equations proved but slightly more useful than simple regressions with depth or drainage in providing guides for productivity estimates. The two species reacted similarly to the soil-site factors tested, giving no indication that Japanese larch is more tolerant of impeded soil drainage.

Within the area represented, site productivity for the two larches can be estimated by means of the depth and drainage relationships or through soil type groupings.

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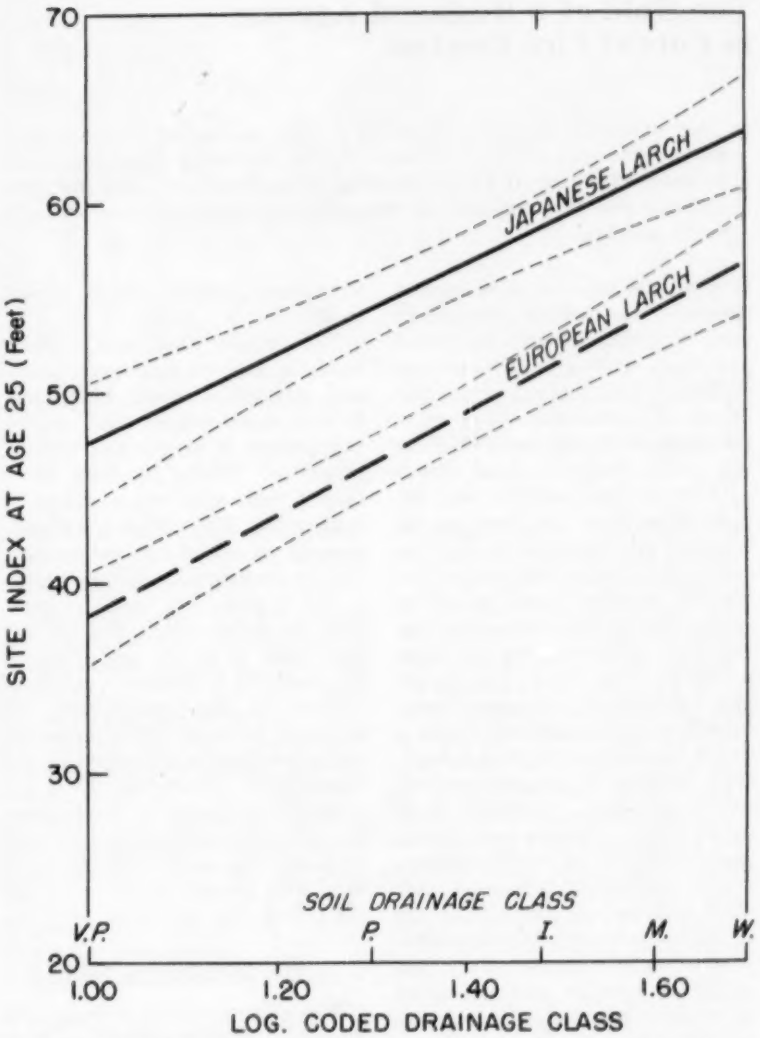

FIG. 3.—Relation of site indexes of Japanese and European larch to soil drainage class, with limits of the .95 confidence intervals. (Abbreviations indicate, respectively, the Very Poorly, Poorly, Imperfectly, Moderately, and Well Drained classes.)

The Role of a Regional Agency in Forest Fire Control

John W. Lehman
and Ralph A. Vogenberger
Tennessee Valley Authority, Norris

In this article the authors summarize forest fire control activities and accomplishments of the Tennessee Valley Authority during its first 20 years. They stress TVA's working relationship with local forestry agencies and the approach to integrated resource development on a watershed basis.

How can a regional development agency of the federal government most effectively advance watershed protection in the area of its responsibilities? This was one of the first questions confronting the Tennessee Valley Authority in 1933. Here was a new kind of federal agency with broad responsibility and authorization from Congress for developing all resources of the Tennessee River basin. Its area of operation included parts of seven states, each already engaged in conservation activities. Some of these programs, like forest fire control and agricultural extension work, were financed in part with federal funds. In all seven states a federal-state pattern of cooperation was well established. Although state conservation programs were handicapped by lack of public support, funds, and trained personnel, each state had made a start. How was TVA to carry out its responsibilities so as to strengthn state conservation agencies and not upset or confuse established cooperative relationships?

The early 1930's were turbulent times. The depression had weakened public faith in local institutions; confidence in local government was shaken. People were demanding and expecting drastic federal action in many areas—in conservation, in agriculture, in fiscal controls, in unemployment relief. In such a climate the TVA Board of Directors faced a wide variety of administrative problems; policies had to be developed for all programs, including resource development. In contrast to the then current fashion of expanding federal functions, the directors decided that TVA should do independently only those things not already being done—things which only TVA, as a regional agency, was equipped to do.

This meant that every effort would be made to encourage, assist, and strengthen local, state, and federal organizations, both public and private, in carrying on needed programs. Where interests overlapped, there must be a minimum of duplication. While TVA might supplement, it would not assume any local or state responsibilities. Neither did it seem wise simply to provide the states with sufficient federal funds to do the job. Thus it was that TVA became a working partner in the development of stronger, broader, better financed, and more effective state and private conservation programs. TVA responsibilities would be discharged, its objectives accomplished, as and when other agencies—notably state, local and private—were doing all the things that needed to be done.

The Situation in 1933

Two obvious and vital watershed problems in 1933 were forest fires and soil erosion. Early in the Civilian Conservation Corps program, 25 camps were assigned to the Valley to work primarily on gully control and reforestation. The fire situation, however, was somewhat more complex and did not lend itself so well to direct labor action and demonstration. Deliberate burning of woodlands was a tradition with many people in the Valley. The public in general had remained indifferent. National forests were receiving a fair degree of protection, but private forest lands were suffering tremendous losses each year. (The extent of this loss was not clearly identified until 1938.)

While state fire control organizations had been established and had made some progress, two obstacles stood in the way. One was apathy on the part of the general public; the other, a direct result of the first, was the limited funds available for protection. In 1933, only three of the seven Valley states had extended organized protection into the 125-county Valley area. North Carolina protected some 775,000 acres in six Valley counties, and Virginia approximately 828 000 acres in five counties. Tennessee provided limited protection to about 5,823,000 acres in the Valley. Only 50 percent of the Valley's 14 million acres of forest land was receiving any kind of organized protection.

Statistics for 1933 show that in this *protected* area 2,376 fires burned 260,102 acres. The size of the average fire was 109 acres. Almost 3½ percent of the protected area burned each year. Estimated burn on *unprotected* areas ranged from 10 to over 30 percent.

Each of the states was feeling the effect of the depression. They were hard pressed to find funds for even a skeleton protection force in organized areas. In 1933 forestry expenditures, including state, federal, and private funds, for the seven Valley states totaled only $450,000; they employed only 36 foresters. By comparison, they employed over 300 foresters in 1952 and forestry expenditures had increased to $8,942,000.

Program Needs in 1933

Analysis of the Valley fire situation in 1933 revealed four high priority needs: (1) A change in public attitude with respect to forest fire damage and forest fire prevention, (2) more adequate support—both moral and financial—for the state divisions of forestry, (3) more comprehensive fire control planning, and (4) more intensive control in protected areas and extension of protection to all forest lands.

Although public education to the

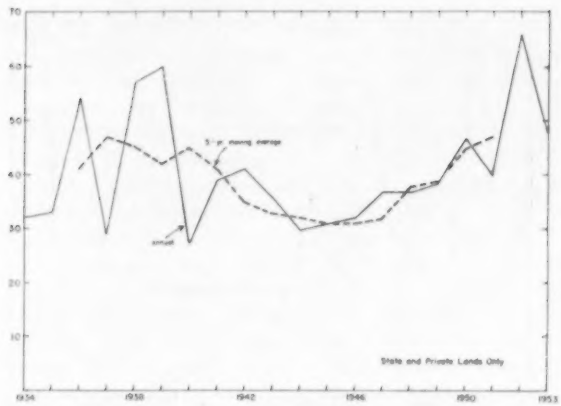

FIG. 1.—Number of fires per 100,000 acres protected in 125 Tennessee Valley Counties. 1934-1953.

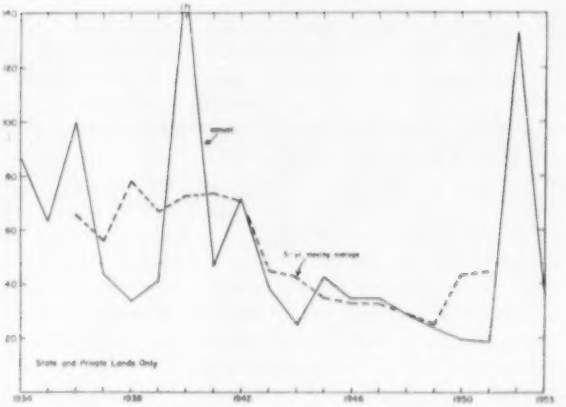

FIG. 2.—Size of average fire (acres); 125 Tennessee Valley counties. 1934-1953.

damage of burning and the need for preventing forest fires was of first importance, opportunities for TVA help varied by states and counties. The needs were interrelated and each one received attention as and when agency and public readiness permitted. All activities were designed to meet needs in accord with the principle of support for state and local action.

Early Aids to Program Development 1933-1943[1]

Numerous activities were carried on in an attempt to develop a public awareness of the forest fire problem—to plant in the average citizen's mind the realization that fires were causing a tremendous loss to present and potential timber, wildlife, recreation, and watershed protection values. Following the successful pattern established by the American Forestry Association in the late 1920's, a series of fire prevention movie programs was launched in cooperation with the states. As a refinement of the original idea, the movie operator concentrated his work in a small area, returning to the same locations with a different program each month for a period of six to eight months. In addition to showing movies, he made personal contacts, distributed literature, and worked with local newspaper editors.

These intensive fire prevention programs, usually organized on a county basis, began in 1936 and continued through the early part of 1942. They included 4,500 meetings in 53 counties; total attendance was almost a million. It is the consensus of both state and TVA personnel that this work was effective. As tangible evidence, every county involved in one of these projects is now organized for protection and is contributing county funds for fire control.

The few available films were not particularly applicable to Valley conditions and needs, so TVA took the lead in producing several local fire control movies. Scripts were written, reviewed by state foresters, and then filmed. "Ten Thousand Fires" was filmed in 1940. It was a two-reel, 16 mm color film with sound. Since 1940 dozens of prints of this film have been purchased by other agencies. It has been shown hundreds of times, both in the Tennessee Valley states and throughout the United States. "Burn Brush Carefully" was produced in 1942. It was one reel, black and white, with sound, available in both 16 and 35 mm. This was developed in conjunction with a printed brush burning leaflet and showed recommended safe methods of burning brush and sedge fields. Two other short films were produced for local use in Wayne County, Tennessee, and Tishomingo County, Mississippi.

In an effort to reduce the number of fires resulting from brush and debris burning—a major source of trouble in the region—the brush burning leaflet was printed in cooperation with each state so that the appropriate state fire laws could be included as a part of the pamphlet. These leaflets were so well received that additional printings finally totaled 135,000 copies. Extra printings were also made by the states and other agencies for use outside the Valley.

To meet the need for simple fire prevention posters, several were prepared on the subjects of brush burning, wildlife, the cigarette smoker, and careless use of matches. Some 28,000 of these were printed and distributed.

Arrangements were made for TVA-CCC erosion control camps to back up state fire control forces as a second line of defense should the fire situation get beyond control. Over the period of their operation, these camps suppressed more than 2,000 fires. They also assisted state protection organizations in the construction of fire control facilities, including nine lookout towers, 350 miles of telephone lines, and 300 miles of improved truck trails and fire breaks.

Technical assistance to the states covered a wide range. To provide for better detection, TVA foresters surveyed proposed tower sites. The detailed, accurate planimetric and

[1]The authors understand and in no way wish to minimize the tremendous importance of federal Clarke-McNary assistance to the states in development of fire control programs. In this summary, however, an attempt has been made to describe only the role of the agency with which they are associated.

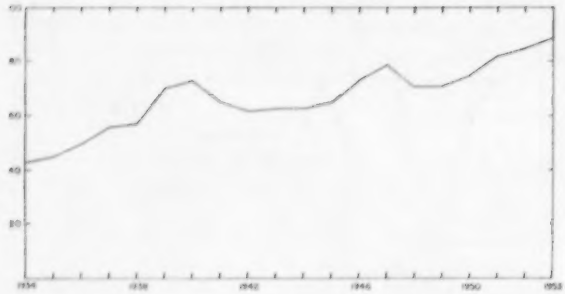

FIG. 3.—Percent of state and private forest land protected; 125 Tennessee Valley Counties. 1934-1953.

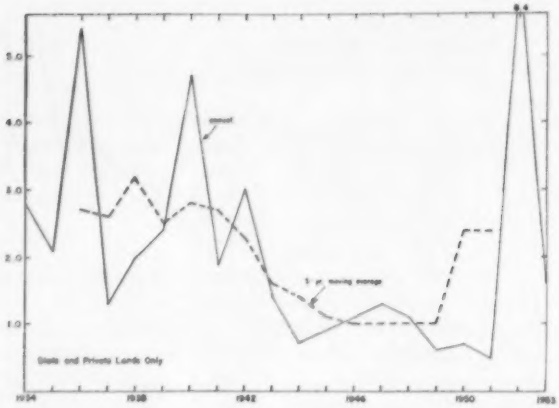

FIG. 4.—Percent of protected area burned; 125 Tennessee Valley Counties. 1934-1953.

topographic maps, prepared by TVA engineers, were an invaluable aid in this region where maps had been inadequate. On them a mapper could accurately sketch in the area visible from a proposed lookout point. Alternate sites could be compared with one another and the very best developed as links in a planned detection system. Some 152 points were mapped and evaluated as possible tower sites. To further expedite and cheapen visible area mapping, a portable 60-foot tower was designed and fabricated. It was made available to the states and has since served as a temporary lookout tower under emergency conditions.

To help determine the maximum distance individual towers could effectively cover, a number of haze meters were acquired and placed in service. These meter records, along with visible area maps, were used by the states in planning detection systems.

Around 1939 the U. S. Forest Service's Southeastern Forest & Range Experiment Station at Asheville, N. C., developed a simple method for systematically determining fire danger. TVA purchased equipment for eleven fire danger stations and set them up throughout the Valley in cooperation with the state foresters. Later, all of these stations were transferred to the states. They helped to initiate early recognition of the value of danger measurement in fire control planning.

Comparative surveys were made of the forest fire situation county by county to determine which were in greatest need of additional protection and what the possibilities were for improving the situation. As a result, the more acute fire situations were pin-pointed. For example, three counties soon showed up as special hot spots. The facilities of both state and TVA were concentrated on them, and shortly thereafter all three voted funds to join the state protection system.

Surveys to determine the exact location, size, and cause of every fire occurring within a given area and period of time were conducted at the request of state foresters. Some of these surveys were in unorganized areas to solicit county participation, some in organized areas to evaluate control effectiveness.

Public opinion surveys made before and after intensive prevention programs enabled state personnel to plan more effective programs.

At the request of state officials, TVA foresters contacted county officials, forest landowners, timber industry representatives, and other key individuals and groups in selected unorganized counties. Purpose of the contacts was to explain the economic value of forests to the county, the damage caused by fires, and the kind of fire fighting organization the state had elsewhere. This procedure was usually effective and with few exceptions resulted in county appropriations and requests for extension of organized protection to the county.

Working together, state and TVA foresters prepared fire plans for a number of communities that were interested in doing something themselves prior to state organization. These plans included organization of crews, area to be covered, location of fire tools, and plan of action. They also were a powerful force for preventing fires. In many cases, they were primarily responsible for a county's appropriating the necessary funds for organized protection.

In all of its activities, TVA's first interest was in the watersheds immediately above its dams. These had high watershed protective values and their protection was given first priority.

The Concentrated Area Demonstrations—1943-1953

While results were sometimes discouraging, progress was being made. With an already changing public attitude and with strengthened state organizations, it appeared timely in 1943 to develop concentrated, area-type fire prevention projects. The idea was discussed with State Forester Fred Pederson of Virginia, who at that time had perhaps the strongest and

most efficient fire control organization of all the Valley states. Out of these discussions came the first cooperative term project whereby TVA contracted with the State of Virginia to do a specific fire prevention job in three southwest Virginia mountain counties, an area of high risk where communication and suppression were difficult. Objectives, procedures, and specific annual work plans were developed jointly. The project was administered by the state. Part of the cost was borne by TVA. Results at the end of four years were gratifying. The number of fires was reduced; size of average fire was cut in half; burned area was reduced to less than one-third the previous annual loss; 85,000 additional forest acres were placed under protection.

Using the successful Virginia project as a pattern, similar projects were completed in North Carolina with 15 counties and in Alabama with 12 counties.

The working arrangement, common to all of the contractual projects, was in the nature of a partnership. Even though the aims and objectives of the states and TVA with respect to the fire control were mutual, the specific common objectives within the geographic area involved were outlined in the contract. Major emphasis was on building up favorable public attitude. Formal project agreements were developed and signed by the state forester and the director of TVA's Division of Forestry Relations. The project statement described the need for the project and its scope. It specified definite objectives, procedures, schedule of work, duration, and responsibilities of each agency. This was followed by annual work plans, budgets, and evaluation reports. The state provided supervision, did the job as called for in the work plans, and reported monthly on significant items of progress and accomplishments. In the major projects here illustrated, state, county, Clarke-McNary, and private contributors shared 87 percent of the cost; TVA's share was 13 percent. But this small TVA contribution was just the little extra the states needed to get off the defensive and onto the offensive. Suppression activities had taken almost all of their funds; nothing much was left for prevention.

One provision of the demonstration contracts had to do with the protection of TVA's reservoir lands. In its early days, TVA had its own fire protection organization because state protection organizations were swamped with the job of protecting private lands. After the dams were built, much of the land necessarily acquired in conjunction with establishment of the reservoirs was transferred to other public agencies or sold at auction. With less acreage to protect and with state organizations gaining in strength, the job of protecting TVA lands was transferred by contract to the states as rapidly as they were able to take it over. Under state protection, the narrow strips of land comprising the TVA ownership pattern are merged with large blocks of adjoining lands for protection purposes, thus permitting substantial reduction in costs and eliminating possible confusion. (Such arrangements are now in effect in Alabama, Kentucky, Mississippi, and Tennessee.)

Results in North Carolina

The North Carolina project was completed in June 1952 after having been in operation for five years. While the projects conducted in Virginia, Kentucky, Tennessee, and Alabama were similar, the more recent North Carolina project with its later refinements is singled out here as an example of objectives and accomplishments.

This project was designed to provide adequate protection in the 15 Tennessee Valley counties of North Carolina in two major stages: first, to round out and strengthen the fire control organization and, then, to concentrate on reducing the number of fires. It was set up as a part of the state's regular fire control program and was administered in the field by district foresters located at Asheville, Lenoir, and Sylva.

At the outset, the forest fire problem was recognized as one involving people — their attitudes, their interests, and their customs. Therefore the development of a more favorable attitude on the part of the public in general was emphasized. The basic assumption was that greater interest and support could be secured if people actively participated in the program. The underlying objective in every phase of the job was to obtain the active participation of other people in addition to the fire control organization. Newspaper editors and reporters, radio station managers, civic club leaders, storekeepers, teachers, industry representatives, key citizens, individual landowners, and many others were all invited to participate in one way or another. In almost every case they accepted the invitation willingly. So they were given specific jobs to do—nothing very time consuming, but something that would stimulate their interest and make them feel that they were contributing. This approach not only brought about a better public understanding of the problem and the job, but put hundreds of people to work on the problem who did not have to be paid.

Accomplishments during the five-year term of the project were outstanding in several respects. The most obvious and significant result was a decrease in area burned. The average annual burn was reduced from an average of 1.6 percent for the preceding five years to 0.22 percent during the project period. Size of the average fire dropped from 50.35 acres to 11.13 acres. No significant reduction in number of fires was apparent from the records, but this is misleading. The larger, more efficient suppression organization fought and reported all fires during the five-year period, whereas in previous years many had missed the record sheets. On the whole there was real progress and the groundwork was well laid for rapid and continued progress in the future. Funds available for fire control work in 1933 averaged about one cent per acre for the area protected. In 1952, for protecting more than twice as much forest

land much more intensively, approximately seven cents per acre was available.

Present Situation in Region

The forest fire situation for the Valley as a whole, while still a serious problem, is generally improved. The percentage of area burned annually is steadily decreasing. State agency appropriations are approaching adequacy. Approximately 90 percent of the Valley forest land is now receiving some degree of organized protection. In an average year only about one percent burns over. Few people burn deliberately.

The attitude of the general public toward forest fires is now definitely favorable to protection. This was reflected during the critical 1952 fall fire season by the relatively small number of fires in the Valley, considering the prevailing weather conditions and ease with which fires could be started. It was also reflected by the hundreds of citizens and the many organizations that volunteered their services. A number of companies donated manpower and heavy equipment; newspapers and radio stations gave effective publicity. In Tennessee, a group of citizens formed a committee to see what could be done to improve fire protection. They raised enough money to employ three forestry consultants to look into the matter. Their report and recommendations got wide distribution; each member of the state legislature received a copy.

The state forestry agencies have recruited additional personnel; they are adding new facilities. Training and problem analysis receives more attention. In terms of staff and equipment, fire protection organizations are much improved. Generally their personnel is competent. While no state is overstaffed, there are few cases of critical understaffing. There is still a need for additional communication and detection facilities and heavy fire fighting equipment, but these needs are gradually being met.

The general public, indifferent only a few years ago, is now definitely opposed to burning the woods. For example, a 1952 survey of the status of management on private lands reveals that 83 percent of the woodland owners in the entire region are now interested or actively working for better fire control—over 10 percent with over 2,000,000 acres have assured control on their lands. This is reflected in increased state appropriations and citizen action. Adequate fire control for the region is now in sight.

Present Activities

As fire protection in the region gradually approaches adequacy, what, if anything, remains to be done? The state agencies and TVA have been examining this question. Currently, attempts are being made to find out precisely how and why fires get started. How do you reduce the number of fires? What are the reasons behind the causes? What are justifiable public expenditures on private lands? Where is the point of diminishing returns in terms of area burned and funds expended?

Take fire causes for example. Though the states have for years been developing statistics on fire causes, the reasons why so many people permit woods to burn still remains an enigma. Usually fire crews and supervisory personnel are so involved with suppression during fire season they have too little opportunity to determine specific reasons for fire origin. There is a genuine need for more complete basic information about the causes of fires, precisely how they get started, and the psychological motivation or reasons. This kind of information would be invaluable in planning and conducting fire prevention.

TVA now has a contractual project with one state (to cover three fire seasons) in which one man is assigned the primary job of determining specific causes of fires. He will (1) make a thorough investigation of every fire, (2) determine its size and make a damage appraisal, and (3) interpret and evaluate data collected at two fire danger stations. Upon termination of the project, it is hoped that sufficient information will have been obtained to at least partially answer the fire cause question in the vast Cumberland Mountain area of Alabama, Tennessee, Kentucky, and Virginia.

The question of how to reduce the number of fires has been raised innumerable times. It has particular significance in areas where an efficient organization has the fire suppression job well in hand. In such areas the percentage of burn has been drastically reduced but the number of fires remains high. Although this is in part the result of increased efficiency, at least one southern state forester believes the number of fires is actually increasing.

To determine effective methods of reducing number of fires, TVA and the State of Tennessee have under way a project designed to *eliminate* all fires in a limited area. The area selected is contained entirely within one small watershed of approximately 193,000 acres. Here the causes of fires have been determined for previous seasons. About 65 percent were the result of debris burning; incendiarists, hunters, and smokers were each responsible for about ten percent; lumbering operations accounted for the remaining five percent. Fire prevention methods developed in this area should have application elsewhere.

Where reasonably adequate fire control has been established, a frequently raised question concerns the practical limit of expenditures. In other words, at what point is it impractical to ask taxpayers to provide more money to further reduce the area burned? In cooperation with the North Carolina Division of Forestry a project is under way to determine for 2 individual county units this point of diminishing returns. The U. S. Forest Service and the Southeastern Forest Experiment Station are interested in this project and are lending assistance in its planning.

Summary

In summarizing TVA's participation in forest fire control during

the past 20 years, these general observations are pertinent:

1. The decision to work with and through the state divisions of forestry has produced results. It has helped to strengthen them, and protection has been extended and intensified in the Valley more rapidly than otherwise would have been the case.

2. TVA never attempted to develop an independent fire control program or organization. All activities were designed to deal with major needs as they existed at the time. Although specific on-the-ground results were not always immediately apparent, overall progress throughout the Valley has been reasonably satisfactory.

3. The concentrated area demonstrations have produced the most spectacular results. In all cases, they have brought about an improved fire record, a stronger state organization, and a more favorable public attitude.

4. Although satisfactory protection standards have not yet been reached in certain sections of the Valley, some effective cooperative approaches have been tested and demonstrated. Answers are being sought to several currently important questions.

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Gifford Pinchot Oil Painting Presented to Forest Service By Weyerhaeuser Timber Company

As a salute on its golden anniversary, the U. S. Forest Service on April 28 received an original oil painting of its first chief, Gifford Pinchot, from the Weyerhaeuser Timber Company of Tacoma, Wash.

The picture of Mr. Pinchot, by Stan Galli of San Francisco, is the first in a series of personalities in forestry and conservation to be used by the Weyerhaeuser Timber Company to stimulate public interest in the wise management of privately owned forests, tree planting, and forest conservation generally.

The picture of Mr. Pinchot has been published in several national magazines including the May issue of the JOURNAL OF FORESTRY, initiating a new advertising series which will feature men who have made outstanding contributions to conservation in the fields of forestry, education, recreation, and wood utilization.

Bernard Orell, vice president of the Weyerhaeuser Sales Company, St. Paul, Minn., (left, in accompanying picture) presented the painting to Forest Service Chief Richard E. McArdle, at a program attended by members of the Forest Service, representatives of forest industry, and the forestry profession.

Some Lessons from Europe in Forest-Big Game Management

Fred W. Johnson and Lowell Adams[1]
Forest Service, Missoula, Montana

Damage to forests by big game on overstocked ranges is a chronic problem in many areas throughout the United States. Pending relief by herd reductions, it is suggested that forest regeneration may be furthered by rotational fencing similar to practices in operation in Europe. The cost of such fencing is moderate compared with current costs of reforestation by planting seedlings.

IN MANY AREAS in America wild ruminants are seriously retarding —even preventing—reforestation.

Each acre of forest land that fails to become restocked with seedlings today means one less acre of harvestable timber at the next rotation. The fact that this loss will not become operative until harvest time, some 100 to 150 years from now, lulls some resource managers into complacent improvidence. We must be constantly alerted to the fact that the reproductive period is a critical part of silviculture. Today we have already accumulated a stockpile of unregenerated forest acres. Each year the stockpile grows.

Swift (*9*) rates browsing by deer (*Odocoileus virginanus borealis* [Miller]) as the greatest stumbling block in the production of future Wisconsin forests. Its destructiveness out-ranks fire one hundred to one!

Adams (*1, 2, 3*) found that deer wintering in a ponderosa pine (*Pinus ponderosa* Laws) forest in Montana browsed intensively on the seedlings of pine and Douglas-fir (*Pseudotsuga menziesii* var. *glauca* (Beissn) Franco). Comparisons of planted pines and seedlings inside deer-excluding fenced plots and adjacent check plots showed that deer destroyed nearly 90 percent of the plants and 84 percent of the natural pine seedlings. Sixty-five percent of the Douglas-fir seedlings were killed by browsing.

Krefting (*8*) found that 23 to 31 percent of the jack pine seedlings (*Pinus banksiana* Lamb.) in a plantation were killed by deer in 2 years.

Aldous (*4*) states that "natural reproduction of northern white cedar (*Thuja occidentalis* L.) is retarded by deer more than by any other factor. . . . Wherever deer are plentiful, white cedar reproduction will not become established." And, further, "Wherever heavy or even moderate browsing is found, it can be assumed that coniferous reproduction, other than spruce (*Picea glauca* Voss), will have little chance of survival."

Similar conditions are reported for many other parts of the United States.

Critical as this relationship is between big game and the forest, corrective efforts are painfully slow and often ineffectual. In some areas game managers are trying to reduce large deer herds—not as reforestation measures, but to restore over-used deer ranges. To the extent that such good deer management results in improved reforestation, the game managers' objectives coincide with the foresters' objectives. But it is doubtful that the two purposes are fully served by good game-range management alone nor is it at all apparent that game managers will achieve their objectives of adequate deer reductions *in time* to avoid real shortages to future and even current generations of timber users. Therefore, the forester is perforce engaged in deer management and he must look upon the species not only as a recreational resource but also as a natural biotic factor of the forest environment which must be controlled.

Two approaches are available to the forester in cooperation with the game manager. First, he should attempt to establish an equilibrium between forest and game by improving game range and bringing game numbers within the carrying capacity of the range. The second approach is made necessary by the fact that this equilibrium is not being established on many forest-game areas. Game herds are allowed to build up to such an extent that forest reproduction is damaged. The second approach, therefore, consists of interim expedients to protect the forest. It is with regard to this second kind of effort that we wish to explore here possible guidelines in Europe.

Forest Game Management in Europe

During the summer of 1953 the senior author visited deer feeding stations in Bavaria and in Denmark. In both countries, and in other parts of Europe, large populations of red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), and fallow deer (*Dama dama*) are maintained in the forests. As in America, conifer reproduction is destroyed and winter game range is degraded by these large populations. But special management practices are followed to alleviate these influences.

Forest-wildlife management in Europe is based on three primary activities — heavy cropping of game, winter feeding, and rotational fencing. About 30 percent of the deer population is harvested every year—a cropping rate which has seldom been attained in America. Still the herds remain large.

In winter the deer assemble on their winter ranges which are small in comparison with the summer range. To compensate for the limited winter feed, the deer are provided with supplemental feed. For many decades European foresters have practiced this artificial feeding. Forstmeister Ernest Deppisch, of the Bavarian Forest Service, showed one of us some of the feeding stations and explained the methods used in this supplemental feeding. The stations are located

[1]Respectively, in charge, Section of Wildlife Management, Forest Service, U. S. Dept. Agric., Region One, Missoula, Montana, and Wildlife Research Biologist, Fish and Wildlife Service, in cooperation with the Intermountain Forest and Range Experiment Station, Ogden, Utah.

Photo by F. W. Johnson

FIG. 1.—Plot fenced to exclude deer and allow the forest to germinate, Denmark.

Photo by F. W. Johnson

FIG. 2.—Another view of the deer exclosure. Note the heavy growth of young trees inside and the grass and mature trees outside the fence.

at the confluence of major drainages in mountainous areas within the winter range. Supplies of mast and cured hay from mountain meadows are stored for winter use in barn-like structures and are fed as needed. In this way more animals are carried through the critical season and are able more fully to stock the abundant summer range.

Adjacent to the feed lots conifer seedlings and other natural browse species are sorely abused. This is also true, to a lesser degree, throughout the winter range. Without further management, the trees and shrubs would not successfully reproduce themselves and the winter ranges would probably revert to grasslands. To prevent this, fences are built to keep deer out of scattered plots of ground.

Fenced areas are from 5 to 10 acres in extent. After conifer and hardwood reproduction has become established and grown beyond deer reach on these plots, the fences are taken down and rebuilt around other damaged plots.

Danish forests north of Copenhagen were visited also. There the red deer and fallow deer are abundant. Danish foresters also practice fencing to obtain forest and browse regeneration. The photographs (Figs. 1 and 2) show the type of fence used and the forest growth obtained.

Deer problems and use of fences to protect forest regeneration are discussed by Güde (*5*). He attributes increased numbers of red deer in central Europe to the decrease of large carnivores. The deer food supply is decreased at the same time as a result of converting lowland broadleaf forests to farmland. The remaining upland coniferous forests provide less food than the broadleaf forests did. Among other management measures, Güde recommends fencing in the areas where deer are fed.

Similar forest-game relationships in Switzerland are described by F. Hunziker (*6*). Forest Inspector Hunziker has informed us (personal communication) that "Since our forests produce too many deer (15 to 20 head per 100 hectare) we must fence all reproduction up to the 6- to 8-year-age classes. However, the hunting brings in so much money (about 2000 Francs per 100 hectares of forest per year) in leasing fees, that we must be tolerant of the leasers of hunting rights."

W. Hunziker (*7*) gives a most interesting history and review of forest-wildlife relationships in Switzerland. In many regions deer destroyed forest reproduction. Many types of repellents and protective devices were tested. This author then states that "In such regions fencing is the only effective protection known."

Application in America

Fencing, as practiced in Europe where small acreages are enclosed, would be prohibitive in cost in this country. However, if large areas, up to 640 acres, were fenced, the cost per acre would be considerably less. Comparing the cost on this basis with the cost of reforestation practices currently in effect here gives a basis for evaluating the practicability of fencing.

In the northern Rocky Mountain section of the United States, nursery-grown conifer seedlings are planted at an average cost of about $35 per acre. A deer-proof fence was built around a 30-acre area in eastern Washington in 1953 at a cost of $1,685 per mile of fence. At this rate, a square mile could be fenced, for example, for $6,740 or $10.53 per acre. Fence maintenance would probably require an additional 15 to 20 percent of the above cost. If such fencing were effective in establishing forest reproduction, it would be more economical than planting.

Of course, it is recognized that many factors other than deer might affect the success of the regeneration. Various treatments of seedbeds and seed sources might be required in conjunction with the fencing. Usually the costs of such treatments could be added to that of fencing and still the total would not exceed the present planting cost.

Also, it should be emphasized that the value of the fencing lies not only in reforestation. Deer forage is also benefited when released from browsing by the fence. When the barrier is removed, such regenerated areas will carry much more

forage than the adjacent heavily browsed areas. Utilization of the new forage supply will partially relieve the browsing pressure on the degenerate portions of the range.

There are many detailed problems involved in a fencing program —many of them perhaps not even apparent at this early stage. For example, fencing must not interfere with normal migration patterns and livestock movements and must not interfere with roadways. Pilot projects on a practical scale should be established for a few years to determine the practicability of the method, its effectiveness in obtaining desired results, and to show up the kind of obstacles that may occur and to provide experience in overcoming them.

Summary

In many parts of America big game, particularly deer, concentrate in great numbers of winter deer range. They destroy both the deer forage and other desirable species of economically valuable plants. Game managers and foresters clearly recognize the need for adjusting herds to range carrying capacity. But such adjustments are slow in being accomplished. Meanwhile, losses in timber production become crucial when viewed in terms of the lost age classes of trees in relation to rotational harvesting.

In Europe similar situations are brought about by winter feeding of deer. This is met by heavy deer harvesting and local rotational fencing to allow forest and forage crops to become established.

It is suggested that fencing practices be tried in America when deer are damaging the forests. Costs of fencing and fence maintenance compare favorably with existing costs of reforestation by planting, which is commonly practiced.

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SOCIETY OF AMERICAN FORESTERS

55TH ANNUAL MEETING

Portland, Oregon. Multnomah Hotel

October 16-19, 1955

See pages 464-466 for information concerning the schedule of events, hotel reservations, and committees for the meeting.

Yield of Seed by Oaks in the Missouri Ozarks

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INFORMATION pertaining to oak seed production is meager and based mostly on general observations rather than on actual measurements. An investigation was begun to determine: (1) the annual variation in acorn production of various oak species and of individual trees; (2) the condition of the acorns when produced; and (3) relations of tree characteristics to seed production.

Acorn data were obtained from 148 oaks, representing five major species (Table 1) and two Ozark localities. Quality of the Dent County site was slightly below average and the Taney County site was about average. The trees varied from 8 inches to 25 inches d.b.h.

The system of sampling and seed examination described by Downs and McQuilkin (*6*) was used. A trap unit and two open quadrats were located under the canopy of each oak.

Results

The results of 6 years' record (1947-1952) are presented as a progress report. They indicate a longer period of observation is necessary to determine the validity of some findings.

Acorn fall usually began in late August, the early drop being primarily immature acorns. Generally, the black oaks retained acorns longer than the white oak; this was particularly true of the blackjack species, which held acorns through the winter.

In years of heavy production, the period of acorn drop was slightly longer. Acorn fall gradually built up to a peak, then tapered off. High winds or heavy rainfall temporarily increased rate of fall, and the first killing frost accelerated acorn drop.

Production of mature acorns varied considerably (Table 1). To reduce the large standard error associated with a small sample and to compensate for the great variation in yield from year to year, a great many trees must be sampled over a period of many years.[2]

No clearly defined cycles of seed production are evident; however, it appears that abundant crops occur at intervals shorter than 5 years. There was a tendency for a good seed year for one species to be also a good seed year for other species, and for a good year in one locality to be a good year in other localities.

There is great variability in acorn production among individual trees. The most prolific of the white oaks in Dent County yielded an average of 7,700 acorns per year, whereas the least prolific produced only 100. Generally, the trees that produced heavily in a given year also produced abundantly in other years; poor producers were consistent also.

Logically, large, vigorously growing trees should be the best seed producers. However, in a geographical analysis of acorn production and observable tree characteristics, seed production by individual trees was not closely related to tree size or growth rate.

Of the two crown classes sampled, there was a tendency for dominants to yield more than codominants, but the difference was not statistically significant.

Simple correlation coefficients were computed for each species between the number of acorns produced and d.b.h., height, crown length, radial wood growth, crown diameter, and crown surface area (computed from crown diameter and height, by assuming the crown had the shape of a paraboloid). The coefficients were practically all statistically nonsignificant. Crown diameter exhibited the highest degree of correlation; wide-crowned oaks of the black group tended to be more prolific than trees with smaller crowns. Also, trees with large crown surface areas generally produced more abundantly than trees with small crowns. Other relationships between acorn production and d.b.h., total height, and crown length were weak. There was no evident relationship between rate of radial growth and acorn production.

The acorns were collected for the period August through December of each year and classified according to maturity. The mature trapped acorns were classified fur-

[1]Game biologist of the Pittman-Robertson Program.

[2]The numerical data presented herein were computed and analyzed statistically by Paul Y. Burns, associate professor of forestry, University of Missouri, Columbia.

TABLE 1.—AVERAGE NUMBER OF MATURE ACORNS PER TREE IN EXPERIMENTAL FOREST STANDS

Year	Black oak (*Quercus velutina* Lam.)	Blackjack oak (*Quercus marilandica* Muench.)	Scarlet oak (*Quercus coccinea* Muench.)	Post oak (*Quercus stellata* Wang.)	White oak (*Quercus alba* L.)
			DENT COUNTY		
1947	600	1,100	0	300	500
1948	2,200	1,000	2,300	200	900
1949	300	300	0	200	600
1950	200	300	0	300	1,900
1951	300	200	100	200	900
1952	1,900	1,500	No data	300	1,800
Average	900	700	500	200	1,100
Standard error	200	100	300	100	400
			TANEY COUNTY		
1947	400	200		300	1,500
1948	1,500	1,100		100	400

TABLE 2.—PERCENTAGES OF IMMATURE ACORNS FOUND IN EXPERIMENTAL AREAS

Forest	Black oak	Blackjack oak	Scarlet oak	Post oak	White oak
Dent County	38	46	31	56	27
Taney County	25	31	—	51	17

TABLE 3.—PERCENTAGES OF MATURE TRAPPED ACORNS IN EACH CONDITION CLASS

Condition class	Black oak	Blackjack oak	Scarlet oak	Post oak	White oak
		DENT COUNTY			
Sound	16	14	14	5	14
Insect damaged	72	71	70	87	72
Wildlife usage	12	15	16	8	14
		TANEY COUNTY			
Sound	32	21	—	12	32
Insect damaged	61	60	—	80	57
Wildlife usage	7	19	—	8	11

TABLE 4.—AVERAGE NUMBER OF SOUND ACORNS PER TREE, BY SPECIES

Species	Average all years	Best year for each species
Black oak	149	815
Blackjack oak	91	186
Scarlet oak	68	1,360
Post oak	11	15
White oak	153	362

TABLE 5.—AVERAGE NUMBER OF SOUND ACORNS PER POUND, BY SPECIES

Species	Dent County	Taney County
Black oak	240	278
Blackjack oak	422	357
Scarlet oak	202	—
Post oak	—	441
White oak	169	104

ther into three classes, namely: sound; damaged by insects; used by wildlife. No study of acorns was made during the winter and the spring seasons. Table 2 shows the percentage of acorns which were immature.

In good seed production years the proportion of immature acorns was somewhat lower than in poor seed production years.

Table 3 shows the proportion of mature acorns classified as to condition when collected.

The proportion of sound acorns was somewhat higher than average in years of abundant seed production in the black oak group, and about average for the white oak group. Less than one-third of the mature acorns were sound when collected. Post oak produced few sound acorns.

The average number of sound, mature acorns produced per tree in the Dent County stand is shown in Table 4.

The proportion of seed damaged by insects was extremely high. Over 80 percent of the mature post oak acorns were wormy, and other species averaged over 50 percent damage. Insect usage was somewhat less in years of abundant seed production.

Table 3 shows that the percentage of acorns used by wildlife was low, averaging about 10 to 20 percent of the mature acorns. The amount of seed consumed in its entirety or carried away was unknown. Wildlife usage was proportionately greater in poor seed years than in good years. Depredation on pine plantations and Eastern redcedar by white-tail deer was observed to be more severe in years of light acorn yields. The present investigation did not reveal consistent wildlife preferences for certain species of oak acorns.

Weights of mature acorns were taken following a storage period of 1 to 3 weeks. Thus the observed weights are smaller than weights from fresh acorns would be, due to loss of some moisture. However, the results indicate approximately the number of acorns of each species equivalent to 1 pound. Sound acorns weighed appreciably more than insect-infested acorns. The sound acorns are most important in reforestation and as wildlife food; their weights are presented in Table 5.

Conclusions

The following conclusions from this study, supported by a review of the literature, have important implications for forest management in producing timber and wildlife crops.

1. Abundant seed crops are not produced every year; yields are irregular and variable from year to year.

2. General and simultaneous acorn crop failures of all species are unlikely.

3. Individual trees vary greatly in ability to produce acorns. The variability among trees in the dominant and codominant crown classes is not consistently related to measurable tree characteristics, although there is a tendency for large-crowned oaks to produce more seed than small-crowned oaks.

4. A high proportion of acorns fail to mature.

5. A large proportion of matured acorns are damaged by insects (over 50 percent, in this study).

6. A relatively small proportion of acorns are both sound and mature.

7. Browsing of pine and Eastern redcedar by white-tail deer is more severe in years of poor acorn yields.

8. Usage of acorns in the trap sample by wildlife was proportionately less in years of high acorn production.

9. Preferences by wildlife for any certain species of acorns are not evident.

Probably the occasional year of abundant seed production is of great importance in providing reproduction. In poor seed years few viable acorns are available because of insect and wildlife depredations, which probably are limiting factors on oak regeneration. Wildlife does not consume all sound acorns in good seed years, and squirrels may even aid regeneration by leaving buried acorns to germinate. Scarlet, black, and white oaks have an advantage over blackjack and post oaks in regeneration, because of their more prolific yield of viable acorns.

A good food species from the

viewpoint of wildlife management is one that produces abundantly every year. None of the species studied met this qualification.

In artificial seeding, it would be well to plant acorns only in years when acorn production in the locality is high; or, if seeding is done in years of light yields, the seed should be protected from rodents.

In years of acorn scarcity, it might be well to consider the application of protective measures, where feasible, to deter depredation of pine plantations by whitetail deer.

Individual trees which have good production records (or, lacking records, trees with large crowns) should be spared in timber harvests. This practice will increase mast production per acre and allow regeneration of oaks, as well as food for mast-consuming wildlife.

Wildlife managers should attempt to maintain a variety of oak species, so that mast failures will be unlikely. A variety of oaks tends to stabilize the supply of food and, likewise, the populations of wildlife dependent upon this source of food.

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THIS IS ELECTION YEAR

This is the regular biennial election year for officers and the Council of the Society of American Foresters. The procedure for nominating candidates is described on pages 467-468.

Members are urged to exercise their right to nominate the candidates by whom they would wish to be represented on the Council.

ADNA R. BOND, *Chairman*

Nominating Committee

Control of the Fusiform Rust of Southern Pines

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WITH THE clearcutting of stands of longleaf pine the native fusiform rust, caused by *Cronartium fusiforme*, has steadily become more important in the management of southern pine forests. Such clearcutting on ridgeland often released the oaks, the alternate hosts of the fusiform rust, from pine competition. Because natural regeneration of longleaf pine is often slow in getting started, slash pine, the favorite pine for reforestation, was planted north and west of its natural range and on typical longleaf sites within its range. Slash and loblolly pines tend to regenerate more readily than longleaf pine on cut-over land. In some localities protection from fire also contributed to the invasion of cutover land by the less fire-resistant loblolly and slash pines. Thus, by natural and artificial means the two species of pine most susceptible to fusiform rust became more widely distributed and the oaks also thrived under the changed conditions.

Life History

The fusiform rust lives from year to year in the living bark of pines; on oaks it develops annually on the lower side of young leaves. The disease is not transmitted directly from pine to pine but must first pass through a period of development on the oaks, chiefly species of the pointed-leaf, or black oak group (*2*).

The cycle of infection usually starts in March with the production of powderlike yellowish spores on pine cankers and wind dissemination of this inoculum to oak leaves. About 10 days after infection, minute yellowish spots appear on the lower leaf surfaces. In these spots spores of a different type are produced; these can infect other oaks, but not pines. This is the repeating stage of the rust and it serves to increase the amount of inoculum on the oaks.

A few days after the repeating stage first appears numerous brownish hairlike structures, called telia, begin to develop around the margins of the older yellowish spots. Telial columns may appear individually, and soon only the telial stage can be found on oak leaves. If the repeating stage has developed abundantly, nearly a thousand telia may be found on one leaf. Structurally, a telial column consists of independently germinating spores bound together in a matrix. In due course teliospore germination is followed by the formation of sporidia, the spores that can infect pine. The round of infection from pine to oak, oak to oak, and oak to pine occurs only in spring, extending usually from about the middle of March to the middle of June.

Susceptibility of Pines and Oaks

Loblolly and slash pines, important in the reforestation program, are the main hosts of the fusiform rust. Loblolly appears to be more susceptible to infection than slash pine, but once infected, slash pine seems to be more sensitive to invasion of the living bark by the rust. Pitch and pond pines are also attacked. Longleaf pine is relatively resistant to infection. The fusiform rust has not been found on shortleaf pine in the Gulf States and for practical purposes this pine may be considered immune to the disease.

In pine tree nurseries there is usually more fusiform rust infection on slash than on loblolly pine receiving similar cultural treatment. Although this has been accepted as evidence of the greater susceptibility of slash pine, a better explanation is based on difference in germination between the two species. The seed of loblolly pine usually has a long-drawn-out germination period, extending to a month, in contrast to the rapid germination of slash pine seed. In the nursery, seedlings from late-germinating seed escape much infection by developing at a time unfavorable for spread of the parasite. Therefore, the lower percentages of cankered loblolly pines in nurseries probably is due to this delay in seed germination.

The oaks likewise differ in susceptibility to infection. As a group the black oaks are more susceptible than the white oaks. In inoculation trials the fusiform rust infected a larger percentage of black oaks than white oaks and fruited more abundantly on the former than on the latter (*2*). Water oak (*Quercus nigra*), willow oak (*Q. phellos*), and laurel oak (*Q. laurifolia*) are most susceptible to the fusiform rust in nature. Other oaks listed in descending order of susceptibility are bluejack oak (*Q. incana*), blackjack oak (*Q. marilandica*), southern red oak (*Q. falcata*), turkey oak (*Q. laevis*), and live oak (*Q. virginiana*) (*3*).

Distribution of the Disease

The fusiform rust is widely distributed from the Eastern Shore of Maryland, where it is found on loblolly pine, to Florida, Texas, and southeastern Arkansas. The wide variations in amount of rust infection encountered in different localities are associated mainly with differences in forest type; the disease is most prevalent in areas where the more susceptible pines and oaks are closely associated and abundant (*6*). This condition is found most extensively in the southern part of the shortleaf—loblolly—hardwoods forest type east of the Mississippi River. Northward in this forest type, pre-

[1]In the preparation of this paper the writer has used some unpublished data of Howard Lamb and Bailey Sleeth, formerly assistant conservationist and assistant pathologist, respectively, Civilian Conservation Corps, Bureau of Plant Industry, U. S. Department of Agriculture.

valence of the disease decreases because the susceptible pines and oaks are either restricted in distribution or do not occur. Southward, in the longleaf—slash pine type, the disease usually is not prevalent enough to be damaging; however, near streams the association of loblolly pines and oaks often leads to local outbreaks of the disease on both loblolly and slash pines. The disease is negligible in the slash pine "flatwoods" near the Gulf of Mexico, mainly because the high water table of such areas restricts development of the more susceptible oaks.

Canker Development

The fusiform rust infects through the needles or through succulent stem growth before bark is formed, as shown by nursery infections on the leafless part of the stem below the cotyledon whorl. The swelling on the woody part of a tree is called a canker and arises from infected cambium, which forms wood 2 or 3 times faster than healthy cambium. In nursery seedlings, the fungus quickly invades the living bark; often, in 5 or 6 months, a systematically tapered swelling forms; the thickest part of the swelling approximates the place where the fungus entered the stem.

The progress of the disease on large trees is slower than on seedlings, and girdling of the stem or branch depends on the size of the wood at the time of infection. Study of canker growth indicates that branch cankers usually grow toward the trunk faster than away from it and that the rate of growth is greater on vigorous branches than on suppressed branches. Stem cankers usually grow down faster than up. In slash pine, the average growth of branch cankers toward the stem is about 2 inches per year. Growth in length of stem cankers averages about 5 inches per year. On loblolly pine stem cankers extend more slowly.

There is a difference in type of canker development, depending on the species of pine attacked. The swellings, typically large on the trunks of loblolly, are smaller on slash pine. Instead of a swelling, there is often a depressed area, centered near the point of infection, resulting from the death of the underlying cambium. Much pitch exudes over such areas. The effect of the fusiform rust is apt to be more lethal in slash than in loblolly pine.

Practices Affecting Susceptibility to Infection

There is considerable evidence that susceptibility of pines to fusiform rust may be increased by any treatment that hastens the time that trees break winter dormancy. Fertilizing, cultivating, planting on cultivated land before serious soil depletion, pruning of stem cankers, and burning that kills pine foliage increase the amount of fusiform rust infection on slash pine (*1, 8*).

Slash pines that are cultivated after planting, or established on old fields, may have double the percentage of cankered trees compared with those in parallel plantations on uncultivated sites. Moreover, the lush growth resulting from removal of the cankered leader is more susceptible to infection than the growth from leaders of unpruned seedlings. Single winter fires in 5-year-old slash pine plantations killed cankered branches and thus reduced the number of cankered trees, as an initial effect. Fire, however, when hot enough to kill needles but not the branches of saplings, induces an early break in winter dormancy; new needle and shoot growth appear on the denuded branches relatively early in spring when prevailing weather conditions favor spore germination and pine infection. Thus the end result of single fires was an increase in the number of new cankers compared with that occurring on trees of the same size in unburned sites. With larger trees, or where the needles are not killed by the heat of the flames, fire would not induce a new set of cankers.

Geographic Strains and Differences in Rust Infection

Plantations of geographic strains of loblolly and of slash pines have been established in an effort to find strains with resistance to the fusiform rust. The U. S. Forest Service has a plantation in which 4 geographic strains of loblolly pine were established in December 1926 in southeastern Louisiana (*13*). The greatest differences in development and in susceptibility to the disease were reported between a strain from north Georgia and one from Louisiana. The Georgia strain grew more slowly and yet was much more susceptible to rust infection than the local Louisiana strain.

The writer observed that the Georgia trees broke winter dormancy earlier than the Louisiana trees. We are involved here not with a treatment that changed the periodicity of growth, but with an inherent character of an exotic northern strain to break dormancy early after establishment in a warmer and wetter locality. Vigorous growth itself does not predispose pines to infection, but any factor or treatment that causes an early break in winter dormancy seems to have that effect.

In contrast with these observations on loblolly pine, comparisons of geographic races of slash pines have given little evidence that worthwhile differences in susceptibility to the rust exist between strains of this species.

Weather and Outbreaks of Fusiform Rust

Knowledge of the effect of environmental factors on rust infection is of fundamental importance in controlling the disease in forest tree nurseries, in explaining the varying occurrence of the disease in nature, and in interpreting the results of inoculations. In this connection a study was made of the temperature - moisture - time relationship involved in the development and germination of sporidia, the rust spores that infect pine. It was concluded that temperature fluctuating between 60° and 79° F. and humidity close to the moisture-saturation point for a minimum of 18 hours would be needed for abundant infection on pines (*7*).

Yearly differences in prevalence of infection, from 1937 to 1940, at the same nurseries indicated that weather in 1938 was unusually

FIG. 1.—Defect in loblolly pine log caused by fusiform rust branch cankers at the same branch whorl. The canker marked "L" entered the trunk about 1917, that marked "R" started about 1910.

favorable for outbreaks of the fusiform rust and least so in 1937 (*10*). It was unusually warm in February 1938 over a region-wide area. Spores on pine cankers near Rio, Louisiana, were being disseminated by February 18, and young telial columns had developed on water oak leaves near Brooksville, Florida, by February 20. March also was unusually warm, with nearly normal rainfall. Undoubtedly there was a build-up of the repeating stage of the rust on oak leaves before the end of the month. The unusually warm weather in late winter was followed in April by cool weather and general rains, or periods of prolonged high humidity. The presence of an unprecedented amount of inoculum on oaks and the occurrence of weather favorable for infection resulted in serious outbreaks of the fusiform rust in pine tree nurseries in the Southeast and abundant infections in young pine plantations.

At different nurseries and in different years rust infection has been consistently lower in beds sown late than in beds sown early (*3, 12*). Thus as much as 40 to 75 percent less infection has been found in beds sown in April than in March. Still less infection occurred in May-sown beds. These results are linked with the normal climatic changes occurring in the spring in the lower Gulf region east of the Mississippi River. March is usually the coldest and wettest spring month, and May is the warmest and driest. The seedlings that germinate in early spring are likely to develop during cool wet weather that favors the production and germination of sporidia, and therefore infection of pines. Those that germinate in late spring are relatively disease-free because the warm dry weather prevailing inhibits spore germination and infection. Most fusiform rust infection occurs in April.

Rust Damage

On pines the fusiform rust kills young trees and makes larger ones worthless or defective. On oaks, the rust causes only a localized spotting of the leaves. Thus the disease damages pines severely, but causes little, if any, injury to oaks. The amount of damage to pines depends on the prevalence of trunk cankers; branch cankers that never reach the stem have little effect on tree growth.

Young seedlings are attacked in the seedbed, while in the cotyledon stage or shortly thereafter. Serious losses of slash and loblolly pine seedlings occurred in nurseries in 1938 and 1939 (*12*). In 1947 the disease rendered 50 percent of the slash pine seedlings in two nurseries unfit for planting. In 1949, 8 million slash pine seedlings were lost from this cause alone at another nursery. Nursery infection is fatal; of nearly 800 cankered slash pine seedlings planted in 1939, less than 1 percent survived in 1949 (*9*). Young plantations may be badly damaged by rust infections that occur during the first 3 or 4 years after establishment. In an area typical of severe rust damage to slash pine in southeastern Mississippi, 27 percent of 715 original trees per acre were dead, 67 percent were alive but stem cankered, 2 percent alive with branch cankers only, and 4 percent disease-free after 9 years in plantation.

As trees grow older the outright killing from new stem infections resulting from branch cankers is reduced; the larger the stem at the time of infection, the less chance there is that it will be girdled by the fungus. Nevertheless, slash pine saplings and young poles are made worthless by the breakage of stems at the cankers.

In saw logs, cull due to the fusiform rust results almost invariably from the downward development of branch cankers into the trunks. Figure 1 shows a loblolly pine log with 2 rust cankers that had originated at the same whorl but from separate branch infections. The canker was 7 feet long and the log diameter 20 inches. The cull due to

the defect was about 95 board feet. In the same stand the average cull due to 30 stem cankers of branch origin was 76 board feet. Damage from cankers on such large trees may be more serious than the loss of trees from stem cankers occurring during the first five years after plantation establishment. The dying of 50 percent of a dense stand of young trees might not lower the value of the final stand, but cankers on saw-log trees always involves cull.

The amount of damage from the killing of small trees and defects in larger ones will depend on the number of trunk cankers and will vary with (1) the disease potential of the site; (2) species of pine affected; (3) initial stand density; and (4) the use to be made of the trees. Differences in the disease potential of the site cause large variations in amount of infection between different localities in the same season. Thus, in 1938 the weather favored the production and germination of rust spores over an extensive region, yet the disease was almost nonexistent at a nursery in northeastern Florida, compared with 11 to 20 percent cankered seedlings in nurseries in Alabama, Georgia, and Mississippi. This difference was due to the presence of highly susceptible oaks near the latter nurseries, whereas only dwarf oaks of low susceptibility occurred near the Florida nursery. Both loblolly and slash pine are more susceptible than longleaf pine to the rust, and rust damage therefore varies with the species of pine affected. Stand density also affects rust damage. In dense stands the crowns close more quickly than in open stands, branches are killed quickly and the downward development into the trunk of branch cankers is frequently prevented (*5*). In a slash pine plantation of 1941, survival in 1950 was 51 percent or 1,049 trees per acre, for 4.6 x 4.6 foot spacing compared to 41 percent, or 206 trees, for 9.3 x 9.3 foot spacing. Eighteen percent of the trees in the dense stand and 38 percent in the open stand had stem cankers of branch origin. Rust damage varies also with the kind of utilization. For saw logs or piling, stem cankers cause cull or even complete loss of the tree for the intended purposes (Fig. 1). On the other hand, most pulpwood stands are not greatly damaged by the disease since cankered bolts are usually accepted along with sound bolts at pulpmills.

Control in Nurseries

Control of a disease of this type is based on prevention. As a first step, select a nursery site where the hazard of rust infection is low. The disease potential may be determined by noting the abundance and distribution of cankers in the crowns of trees in young stands of native pines within 1 to 2 miles of a given site. The more abundant the cankers are in nature, the greater the risk of loss to loblolly and slash pine in the nursery. Longleaf pine, less susceptible to the rust, is frequently cankered when growing near concentrations of oaks. Cankers on as much as 10 percent of the longleaf would indicate that in some years the potential loss from the fusiform rust would be very serious on loblolly and slash pine nursery stock.

Spraying to prevent fusiform rust infection is routine practice in many forest-tree nurseries in the Southeast (*11*). Ferbam, Ziram, and Dithane Z-78, at rates of 2 pounds in 100 gallons of spray containing 1 pint of Santomerse S or Goodrite Type 4, have given somewhat better control of the rust than that obtained with home-made Bordeaux mixture (4-4-50). If beds have been sown by March 15th, spraying should start as soon as mulch is lifted. With later sowing, applications should be made over the mulch as soon as germination is underway. Spraying at weekly intervals until the middle of June is usually necessary, but in areas where the disease is abundant, 2 applications a week for 3 weeks, followed by one treatment a week, may be needed. Spraying is most effective if treatments are deferred until the fruiting stages of the rust first appear on leaves of oaks in the vicinity of the nursery, deferred when daily average temperatures are not above 56° F., or timed to precede periods of general precipitation or of high humidity.

It has been demonstrated that an oak-free zone, 1,500 feet from the margin of pine tree cultivation, failed to reduce infection in a nursery (*3, 12*).

Fusiform rust is preferably controlled in nurseries by fungicidal treatments, but culling of cankered seedlings, an expensive procedure, becomes necessary at times. This should be done at the time of grading if 5 percent or more of the plantable stock is cankered. In some nurseries, culling for fusiform rust has been done because of the presence of low side branches, which was believed to indicate infection. Studies in 1937 showed that a swelling, not associated with a scar from mechanical injury, is the only reliable rust symptom and that low branches not accompanied by perceptible cankers are not an indication of the disease.

Late sowing, as indicated elsewhere, results in reducing the amount of infection. Although much loss from rust may be avoided by sowing late, unsatisfactory yields of seedlings are likely to result from sowing after the middle of April.

Control in Plantation and Natural Reproduction

In areas of high infection hazard, fusiform rust has often attacked over 80 percent of the slash pine seedlings in 5-year-old plantations. At this level of intensity of infection the disease becomes a serious handicap to reforestation with slash pine. Since little can be done to protect highly susceptible pines from infection in the field, more reliance could well be placed on longleaf and shortleaf pines for planting on their respective sites. The same criteria suggested herein for determining the disease potential at a nursery site could be used for locating planting sites with low disease potential.

Reduction in the amount of stem-cankered trees per acre may be attained by increasing the density of stocking. Fusiform rust never wipes out a stand of trees and the effect of stand density on the prev-

alence of stem cankers is best seen by studying natural stands of varying density. The denser the stand the more quickly the crowns will close and kill cankered branches. The rust, an obligate parasite, will die with the branch. In areas where the intensity of rust infection is high, 4 x 4 foot spacing would be preferable to 6 x 6 foot spacing.

Rust damage arises from trunk infections. Cankers on the trunks of young trees usually cause death or make the tree worthless. By pruning infected branches before the swellings reach the stem some of the damage from trunk cankers may be avoided (*4*). If intensive control measures are possible, the pruning of branch cankers becomes desirable when stands are 2 to 5 years old, where trees with only branch infections are more numerous than those with stem cankers, and when the trees are less than 10 feet tall. In pruning, it is not necessary to remove branches with cankers centered more than 15 inches from the stem. Pruning should be confined to trees free of stem cankers. The decision on whether or not to prune will depend on the prevalence of the disease and the use to be made of the trees.

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Forest Production in a Dynamic Economy[1]

Albert C. Worrell
Associate professor of forest economics, Yale University, New Haven, Connecticut

THE QUANTITY of forest products consumed in the United States is not a stable figure but varies from year to year. More important from the forester's viewpoint than these annual fluctuations, however, is the fact that for some products the changes show a definite trend in one direction.

A particularly striking trend is that in the consumption of pulpwood. Figure 1 shows the course of total pulpwood production—both pine and hardwood—in the South between the years 1939 and 1952. During these thirteen years, total pulpwood production increased at an average annual compound interest rate of 8.5 percent. The southern pulp industry expanded remarkably in recent years, but pulpwood consumption in the entire country has been increasing rapidly for over fifty years. The value (in 1935-39 dollars) of apparent pulpwood consumption in the United States is reported to have increased from 18.2 million dollars in 1900 to 245 million dollars in 1950.[2] The increase during this fifty year period was 5.3 percent annually.

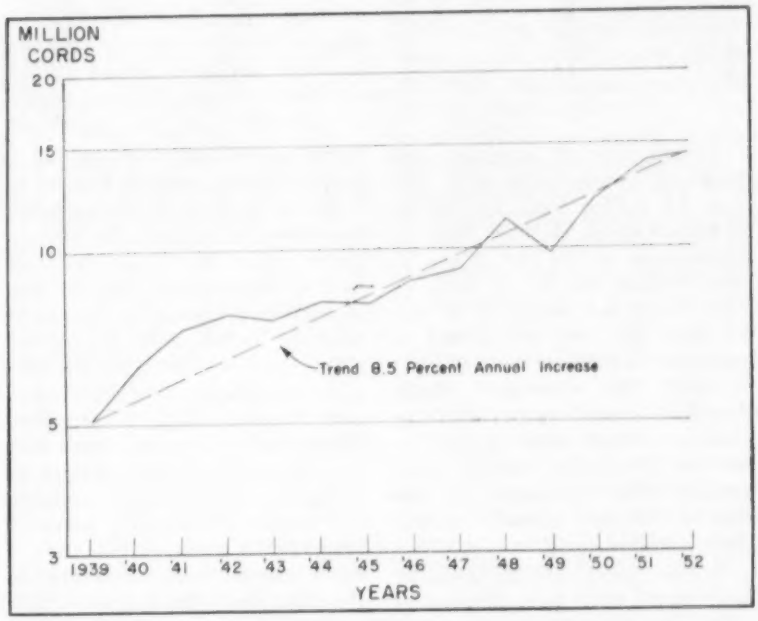

FIG. 1.—Total annual pulpwood production in the South from 1939 to 1952.

These figures show that "sustained yield" does not mean much when we are talking about pulpwood. The southern pulp industry used 4.4 million cords of pine pulpwood in 1939. If our southern forests had been placed under management to produce this much pine wood per year on a sustained basis, they could have supplied only about a third of the 12.8 million cords actually used in 1952. Production plans for growing pulpwood clearly cannot be based on the amount of wood being consumed at the time the plans are made. They must be built around estimates of the amount the industry will be consuming in the years when the crops are ready for harvest. Because of the long growth period of trees, we must plan today for harvests which will be made many years from now. This long-time planning is serious in a dynamic situation like pulpwood production and consumption.

Forest production in an actual economy as complex as ours is affected by a multitude of variables. The amount of timber grown varies with land productivity, composition of the forest, silvicultural practices, landowner characteristics, government interference, and many other factors. It is virtually impossible to analyze economic behavior if we try to allow for the potential changes and interactions of all of these variables. However, we often can get a general understanding of an economic problem by using a "model" in which we assume that most of these factors remain unchanged while a few which interest us are allowed to vary. Such a simplified model is not intended to present a complete picture of the economic process, but rather to show what happens under certain, perhaps rather unreal, conditions. The "answers" obtained from such a model, therefore, cannot be taken as forecasts of real results. All a model can show is what may be expected to happen in general under the conditions for which it is set up.

In this article I will try to demonstrate the problems of forest production in a dynamic economy by the use of a simplified model of the pulpwood growing process. For this model we will make the following assumptions about growing southern pine pulpwood: (*1*) trees grown in even-aged stands by clear-cutting and planting, (*2*) an economic rotation of 30 years with a final yield of 25 cords per acre, (*3*) no yield from intermediate cuttings, (*4*) a growing stock of nine times the annual yield, and (*5*) consumption increasing at a constant annual rate of 5 percent.

What plans should the managers of our pulpwood growing model have made in 1939? At the assumed

[1]This article was written while the author was a member of the faculty of the School of Forestry, University of Georgia.

[2]President's Materials Policy Commission. Resources for freedom. Vol. II. Washington, D. C. 1952.

TABLE 1.—EFFECT OF A DECREASE IN THE RATE OF CONSUMPTION EXPANSION ON THE AREA ACTUALLY PLANTED

Year	Consumption expansion rate	Multiplier for planting area	Area cut over	Area actually planted
1	5.0	4.3	1.000	4.3
2	4.5	3.7	1.045	3.9
3	4.5	3.7	1.092	4.0
4	4.5	3.7	1.141	4.2
5	4.5	3.7	1.193	4.4

5 percent rate of increase, pine pulpwood consumption will rise from 4.4 million cords in 1939 to 19 million cords in 1969. That is, consumption at the end of the 30 year rotation will be 4.3 times as large as at the beginning of the rotation. The trees which will be harvested in 1969 are those planted in 1939. The managers' plans, therefore, should have called for planting enough trees in 1939 to produce 19 million cords of pulpwood in 1969. This despite the fact that in 1939 they actually cut less than 5 million cords.

In our model, 176,000 acres of land would have been clearcut in 1939 to produce the pulpwood consumed. But 760,000 acres should have been planted that year in order to grow the 19 million cords which will be consumed in 1969. Because consumption will increase 5 percent each year during the thirty years that this crop is growing, the area planted for the next rotation must be 4.3 times as large as the area clearcut in the current harvest. What is more, this situation will continue year after year so long as consumption increases at 5 percent. Each year an area 4.3 times as large as that cut over must be planted to provide for the next crop. In 1940, the area planted should have been 5 percent larger than that planted in 1939—or 798,000 acres—because in 1970 pulpwood consumption will be 5 percent larger than in 1969. The area planted each year must increase at the same rate as consumption, but the actual area planted must be a full rotation ahead of the related consumption.

The total production base for continuous wood production in an expanding economy will be larger than that required for an economy in which consumption is constant. If 25 cords were consumed each year, a total production base of 30 acres of land and 225 cords of growing stock would suffice for sustained yield. But when consumption is increasing 5 percent each year, for every acre of land with 30 year old timber ready for harvest there must be 1.05 acres of land with 29 year old timber, 1.10 acres with 28 year old, 1.16 acres with 27 year old, and so on. Each acre of land ready for harvest must be accompanied by 65.4 acres supporting immature growing stock—a total of 66.4 acres—to take care of the 5 percent annual increase. In the same way, there must be 267 cords of immature growing stock behind each 25 cords ready for harvest, or a total growing stock of 292 cords.

This means that in a dynamic economy management cannot get a reliable idea of the state of its resources by comparing the size of its production base (land and timber) with current consumption statistics. The greater the rate at which consumption is changing over time, the more distorted will be the impression which management will get from such a comparison.

Two factors affect how much larger the production base must be in a dynamic situation than that needed for sustained yield. These are the rate at which consumption is expanding and the length of the rotation required to grow the product. If the rate of expansion in our model were only half as large (2.5 instead of 5 percent), the planting area required each year would only be 2.1 times as large as the area cut over instead of 4.3. The total area required to produce 25 cords of wood a year would be 43.9 acres instead of 66.4. If the rate were twice as large (10 instead of 5 percent), the area planted each year would have to be 17.4 times as large as the area cut and the total area required would be 104.0 acres. The rate at which consumption is changing is a critical factor, because the production base required is quite different at different rates.

The length of the rotation required to grow the product also affects the size of the forest production base needed in a dynamic situation. If the 25 cords of pulpwood could be grown in 25 years instead of 30, the area planted each year would need to be only 3.4 times as large as that cut over. The total area required would be only 47.7 acres. By contrast, if it took 35 years to grow 25 cords of pulpwood per acre, the area to be planted each year would have to be 5.5 times that cut over and the total area required would be 90.3 acres. A few years difference in the length of the rotation causes a considerable difference in the size of the production base required. This means that an error in estimating the rate of consumption change would not be as serious on high site quality land or with short-rotation products like pulpwood as it would on poor land or with long-rotation products such as large saw timber.

If the consumption of wood were expanding at a definite and known rate it theoretically would be possible to keep the economy in a state of dynamic equilibrium by adding to the production base at that same rate. Assuming that the economy were in such a state of dynamic equilibrium, what would be the effect of a change in the rate at which consumption is increasing? Let us suppose that the rate increases from 5 percent to 5.5 percent. To take care of the cumulative effect of this increase of 0.5 percent each year from now on, the area planted will have to be 5.0 times as large as the area cut over instead of 4.3 times. An increase of only 0.5 percent in the rate at which consumption is expanding calls for an immediate increase of 16 percent in the amount of land being planted if the economy is to stay in equilibrium. A change in the opposite direction would have

a similar effect. If the rate of consumption increase drops to 4.5 percent, the planting area required will drop from 4.3 to 3.7 times the area cut over. A decrease of 0.5 percent in the rate causes a decrease of 14 percent in the planting area.[3]

In a state of dynamic equilibrium, the area planted each year would be increasing at the same rate as consumption. A decrease in the rate of consumption expansion might cause an actual decrease in the area planted for several years. In our model, for example, a 0.5 percent decrease in the rate of consumption expansion would have the effect shown in Table 1.

If the forest economy were adjusted to some given rate of consumption increase, a change in this rate would have still other effects. If the rate decreased, there would be available each year an area ready for harvest larger than needed to supply that year's consumption. In succeeding years, if the oldest timber were cut first, the cut would eventually all come from 31 year old stands, then 32 year old, and so on. The actual rotation age would increase and there would gradually build up an excess growing stock. If the rate of increase in planting were changed to the new consumption rate as soon as that change occurred (as illustrated in Table 1) an entire rotation would pass before this adjustment affected mature timber. In fact, depending on how much the consumption rate decreased—and how much the rotation was lengthened by the buildup of surplus growing stock—a complete adjustment would not be attained until some years after the end of the first rotation.

Since timber can be stored on the stump, the adjustment to a decreased rate might not be serious, though there would be a temptation to liquidate the excess growing stock which could only be done through price cutting. However, if the consumption rate increased, a more critical situation would exist. It would now be necessary to cut into younger age classes in order to get enough wood to meet the increased demand. The cut would gradually move down into the 29 year old stands, then the 28 year old, and so on. An increase in the rate of planting can have no effect on yield for many years. So if the rate of planting is increased to the new rate as soon as the change is discovered, no increase in output will take place until the stand planted the first year reaches the age class which is being cut in some future year.

If the increase in the consumption rate is not too large, an immediate change in the planting rate will eventually reverse the progression of the cut into younger stands and in time the harvest will return to the original rotation age. However, if a large increase in the consumption rate took place, it might be necessary to cut into the younger age classes very rapidly in order to produce the desired output. Since the amount of merchantable volume drops off as the harvest age is reduced, a point might be reached after a few years when it would not be possible to produce the desired output by cutting further into younger age classes. If the policy were then followed of producing as much of the desired output as possible by cutting everything which reached merchantable size each year, the growing stock might be prevented from ever building back up even though the planting area were being expanded at the same rate as consumption and a rotation ahead.[4]

[3]Economists have long recognized this phenomenon of a much magnified relative change in the production of durable producers goods as a result of a small change in the consumption of the product of these goods. They call it the "Acceleration Principle" and some have suggested it as one of the factors contributing to business cycles.

[4]This appears to be what has actually happened with saw timber in the South in recent years. In order to get enough timber, smaller and smaller trees have been cut. This has eliminated the growth which otherwise would be taking place on larger trees, and a large part of the growth to meet drain is now "ingrowth" from the sub-merchantable size classes. So long as the cut is large enough to take all of this ingrowth, it is impossible to build up growing stock in the larger size classes and thus to return to sawtimber production from large trees only.

Conclusions

Our forest production situation in the United States is, of course, much more complicated than that in the simple model used in this article. Trees are grown in uneven-aged as well as even-aged stands; optimum harvest age varies with species, site, location, product grown and other factors; production can be increased by more intensive management as well as by using more land. But some general conclusions can be drawn from the model which apply to the total forestry enterprise of the country.

Forest production for the United States as a whole must be adjusted on some dynamic basis to match changing demand for forest products. Sustained yield may be a reasonable goal for individual forestry enterprises, but if consumption continues to increase, the total forestry enterprise of the country must operate on a basis of increasing yield. Ideally, the national growing stock should be regulated so that production is increasing at the same average rate as consumption. Short-time fluctuations in demand must be ignored in this regulation and production adjusted to the long-time trend in demand.

Over a long period of years we have been stumbling in the general direction of a regulated national growing stock. There is little we can do now about the existing poorly regulated pattern of age classes except to try to cut them in the order which will give the best balance of yield with consumption over future years. But we can make sure that the regeneration we are establishing today is in line with estimated future consumption. The 1955 class of regeneration must grow into the forest products which will be desired 25, 50, or 100 years from now, depending on species, site, geographic location, and so forth. Will this 1955 class be sufficient to meet that future demand? Our current growth-drain comparisons do not really tell us because they do not say anything about whether this growth can be sustained or, as must actually be the case, increased in the future. De-

spite the uncertainties in estimating future consumption, we have no choice but to base our present production plans on such estimates if we are to come anywhere near to producing the amount of forest products which will be demanded in the future.

This raises the question of how we can hedge against the likelihood that our estimate of the future rate of consumption change will be wrong. We might do this by deliberately planning to increase production at a greater rate than we expect consumption to increase. A better plan might be to set production at some fixed proportion—say 10 percent—above what we expect consumption to be. Both have the disadvantage that if the consumption estimate is correct or too high, there will be a long period in which production will exceed consumption every year. Holding the excess timber on the stump instead of cutting it will only aggravate the situation. This would have serious consequences for private investors in forest production.

A logical function of our large area of publicly owned forest land might be to provide a cushion against errors in the future production-consumption balance. The public forests might well be managed on a basis of producing in excess of their apparent fair share of total national production. If future consumption estimates are low, this excess public production could fill the gap. If future estimates are high, the excess could be held off the market so that the private production could all be sold. This would reduce price fluctuations which might cause private owners either to overcut their growing stock in response to high prices or abandon their operations in response to low prices. It would also furnish a reserve in case of national emergencies. Both of these are legitimate public functions. However, these function could be carried out only if this is accepted as public policy and there is no pressure to sell public timber in order to cover costs in times of slack demand and no objection to heavy cutting of public timber in order to hold down prices in times of brisk demand.

Survey of California Forests Reported

California forests contain 360 billion board feet of saw timber, according to "Forest Statistics for California," recently published by the California Forest and Range Experiment Station of the U. S. Forest Service.

"At current prices for stumpage," said Dr. George M. Jemison, director of the station, "the value of the standing timber alone is estimated to be about 3 billion dollars."

Described by Jemison as "the first intensive inventory of the forest resource of California," the report summarizes forest information. The data were obtained in a forest survey conducted by the experiment station in cooperation with the Division of Forestry of the State of California.

Altogether, forests cover 42.5 million acres, or 42 percent of California. Of this total, 17.3 million acres are capable of growing commercial crops of timber. The remainder, 25.2 million acres, is occupied by open woodland and brush of value chiefly for nontimber uses. California's forests are of high value for watershed protection.

About half of the commercial forest land in the state is located in six northern counties: Mendocino, Humboldt, Trinity, Siskiyou, Shasta, and Plumas Counties. The national forests and private holdings have about the same area of commercial forest land—8 million acres each.

The report shows that seven tree species make up about 90 percent of the state's 360 billion board feet of saw timber. Douglas-fir is the leading species with a volume of 117 billion board feet. The true firs, white and California red fir combined, are next with 89 billion board feet. Ponderosa and Jeffrey pines together include 67 billion. The other important species are redwood, with 36 billion, and sugar pine, 27 billion board feet.

Altogether the forests of California are growing nearly 3 billion board feet annually, according to the report. Most of the timber is in forests composed predominantly of mature and overmature trees with relatively slow rates of growth.

Logging is removing about 6 billion board feet of logs for timber products each year. Of this, 5 billion board feet is made into lumber by 800 mills. This represents 13 percent of the total lumber production of the country, and places California second only to Oregon in lumber production. Other important timber products are plywood and pulpwood.

The new estimates of forest land and saw timber in California are larger than previous estimates, the report says. One reason given is that improved survey techniques were used. Also, tree species such as Douglas-fir and white fir were formerly considered of little value in California, and these species were not fully included in previous estimates.

A copy of the report may be obtained from the California Forest and Range Experiment Station, P. O. Box 245, Berkeley 1, California.

Notes

Influence of White Birch in Restoring Potassium to Deficient Soils[1]

Level "sand plains" of glacial outwash origin occur extensively in the Adirondack Mountains of New York. These deep sands once supported forests of pine, spruce, and hemlock; but their favorable topography led to cultivation early in the nineteenth century. Then, a hundred years of intensive farming without fertilization resulted in depletion of natural fertility. Finally the plains were abandoned about 1900.

In the 1930's, reforestation began. White pine (*Pinus strobus*), red pine (*P. resinosa*), white spruce (*Picea glauca*), and Norway spruce (*P. abies*) were planted. A few years later these species exhibited symptoms which Heiberg and White[2] attributed to a deficiency of potassium in the soil. Subsequently, the symptoms of low potassium availability—slow growth and small chlorotic needles which drop off prematurely—were noted in native white pines of the region.

The nutrition and growth of potassium deficient white pines are, understandably, improved by adding that element to the soil. Apparently white birch (*Betula papyrifera*) trees are quite influential in this respect, according to observations made in an old field at the Charles Lathrop Pack Demonstration Forest. There, under crowns of scattered birches, now about 40 feet high, dense white pine seedling and sapling stands occur. The pines are found on all sides of the birches, but only to the crown edge. None of the characteristics of potassium deficiency are manifested by these overtopped trees. However, isolated white pines scattered throughout the same field, but not growing under birch crowns, exhibit symptoms of potassium malnutrition.

Experimental Methods

Potassium concentrations were determined for the foliage of three white birches, three white pines growing under the birches, and three paired white pines growing in the open. Foliage was sampled from east-facing branches near the center of crowns. Leaves, including petioles, and needles were removed from branches in the field and immediately oven-dried at 70° C. Oven-dried samples were ashed, the ash dissolved with $2N$ HNO_3, diluted to volume, and the aqueous solution analyzed for potassium content using flame spectrophotometry.

A two-pound soil sample was taken with a Cenco tube in the plow horizon under each tree sampled. Soil pits were excavated for sampling to a depth of four feet in the B_3 horizon. Air-dried and sieved samples were analyzed in duplicate as follows: pH by glass electrode; exchangeable potassium by leaching with $1N$ NH_4Ac and subjecting the leachate, after oxidizing organic matter and acidifying, to flame spectrophotometric analysis; total nitrogen by the Kjeldahl method; and acid-soluble phosphorus using $SnCl_2$ as a reducing agent on an extract leached with $0.002N$ H_2SO_4 and analyzed spectrophotometrically.

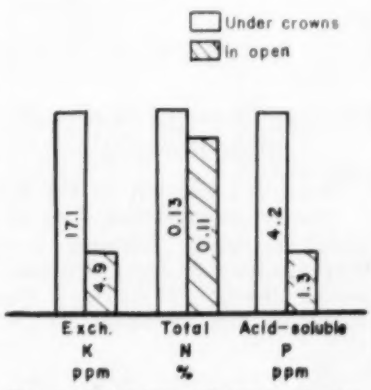

FIG. 1.—Potassium, nitrogen, and phosphorus in plow horizons of soils under white birch and in openings.

Results

Exchangeable potassium and acid-soluble phosphorus were found to be appreciably greater in the plow horizon under the birch-pine groups than in the open. Total nitrogen content was only slightly higher under the canopy (Fig. 1). The pH of soil in the plow zone is a little higher under birch crowns: 5.3 in contrast to 5.1.

Below the plow horizon, exchangeable potassium levels do not differ appreciably. For both sites a rapid decrease in exchangeable potassium content occurs with increase in depth to the upper B horizon. From that zone downward, only traces of the element are present.

Statistically (t test), the differences in potassium concentration in needles of open-grown and overtopped pines are highly significant. Almost twice as much potassium was found in the foliage of those under birch crowns (Table 1).

Discussion

White pine seedlings are usually highly intolerant to the desiccating effect of strong sunlight in open fields. As a result, natural reproduction even on fertile open land suffers heavy mortality rates. No doubt shade offered by birch crowns favorably influences early survival. But not only was the survival rate high under birch canopies: vigor of seedlings and saplings in these dense stands is exceptional. Quite in contrast are trees in the open which show potassium deficiency symptoms. Needles of all open-grown trees sampled were well below the 0.34 percent

[1]From an incidental study to a thesis entitled *Foliar analysis as a method of indicating potassium-deficient soils for reforestation* submitted to the faculty of the State University of New York, College of Forestry, for the Ph.D. degree. Acknowledgement is made to Professors D. P. White and S. O. Heiberg for helpful counsel.

[2]Heiberg, S. O., and D. P. White. Potassium deficiency of reforested pine and spruce stands in northern New York. Proc. Soil Sci. Soc. Amer. 1950. 15: 369-376. 1951.

TABLE 1.—FOLIAR AND SOIL ANALYSES FOR POTASSIUM

Sample pair No.	K in foliage[1] White pine[2] Under crowns	In open	White birch	Exch. K in surface soils[2] Under crowns	Open
	Percent	*Percent*	*Percent*	*ppm*	*ppm*
1	0.55	0.28	0.85	18.5	6.2
2	0.48	0.28	0.58	14.6	4.7
3	0.43	0.26	0.63	18.2	3.8
Average	0.49	0.27	0.69	17.1	4.9

[1]Dry weight basis, August foliage.
[2]Differences significant at 1% level.

potassium level which Heiberg and White considered the critical limit for this species.

White birch trees apparently are able to obtain potassium even on soils which are extremely low in this element. As a result, release of potassium when foliage decomposes is sufficient for significantly increasing the potassium content of the surface soil. On glacial outwash sand plains, this is believed to account for the superior vigor of white pines growing under birch canopies, compared to pines growing in the open.

The condition of the area immediately under the birches prior to the time they seeded in on the old fields is unknown. Did the birch seed germinate in brush or ash piles? If so, the foregoing discussion would need modification, for the soil would have been supplied vital nutrients released from the organic debris following decomposition. Ash piles would of course be fertile sources of readily available nutrient supplies. A condition favorable for establishment and growth of birch, and subsequently pine, would have followed. However, because no peculiarities, such as charred wood, were found in the soil, a more plausible explanation is that the birch, by decay of foliage, enriches the soil directly under its crown.

The continual return of nutrients to the soil through deposition of leaf litter on the surface, followed by decay and leaching, is judged to be an important factor influencing forest soil fertility.[3] In potassium-deficient Adirondack sand plains, applications of maple and pine slash from nondeficient areas and humus from a pine-hemlock forest brought about substantial increases in red pine vigor. This was manifested in faster growth and normal leaf color. Potassium concentrations in needle tissue increased after organic materials collected in healthy stands were added to the soil. The influence of decayed leaf tissue on soil fertility has also been demonstrated for eastern redcedar on abandoned field soils in Connecticut. There, plow zone calcium concentrations are significantly greater under redcedar crowns than under neighboring red pines.[4]

Summary

White birches appear to exert an appreciable influence in increasing exchangeable potassium in the surface of potassium-deficient sandy soils. As a result, young white pines grow well under birch crowns, while those in adjacent openings show symptoms of potassium deficiency.

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[3]Lutz, H. J., and R. F. Chandler, Jr. Forest soils. John Wiley & Sons, N. Y. 1946.

[4]Read, R. A., and L. C. Walker. Influence of eastern redcedar on soils in Connecticut pine plantations. Jour. Forestry. 48: 337-339. 1950.

Freeze Damages Shortleaf Pine Flowers

Phenomena observed on the A. J. Hodges Experimental Area at Many, Louisiana, following low temperatures of 28 degrees Fahrenheit on March 25, 25 degrees F. on March 26, and 28 degrees F. on March 27, 1955, threw considerable light on periodic failures of seed crops and should be of practical interest to breeders of southern pine.

On March 25, shortleaf pine female strobili were in various stages of development from stages 1 and 2 (completely covered with bud scales) to stage 5 (open and ready to receive pollen). The flowers still covered with bud scales suffered little or no freezing damage. Those in later stages of development were severely injured or killed. The cold killed newly opened leaves on several species of hardwoods, and in some species apparently killed or injured the twig tips.

The freeze obviously has greatly reduced the possibilities of a shortleaf cone crop in 1956. This will hamper both natural regeneration and collection of seed for planting.

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A Portable "Pole Ladder"

A portable, jointed "pole ladder" has been devised and used successfully at the Blacks Mountain Experimental Forest to climb pines having no limbs near the ground. Conventional tree climbing spurs, belt, and safety rope are not satisfactory for ascending porcupine rest trees. Spurs injure the smaller trees, they are hazardous to the wearer if not removed before walking considerable distances between trees, and they are inconvenient and time consuming if they are removed after each descent. With the special ladder, any tree having a stout limb between 16½ and 21 feet from the ground can be climbed quickly and easily. Although the ladder was constructed for the special purpose of placing poison blocks, it should be equally useful for climbing trees for other purposes such as cone collecting, pruning, and artificial pollination. Through slight design modification the ladder could be made lighter or heavier, longer or shorter.

FIG. 1.—Plan for a portable "pole ladder." →

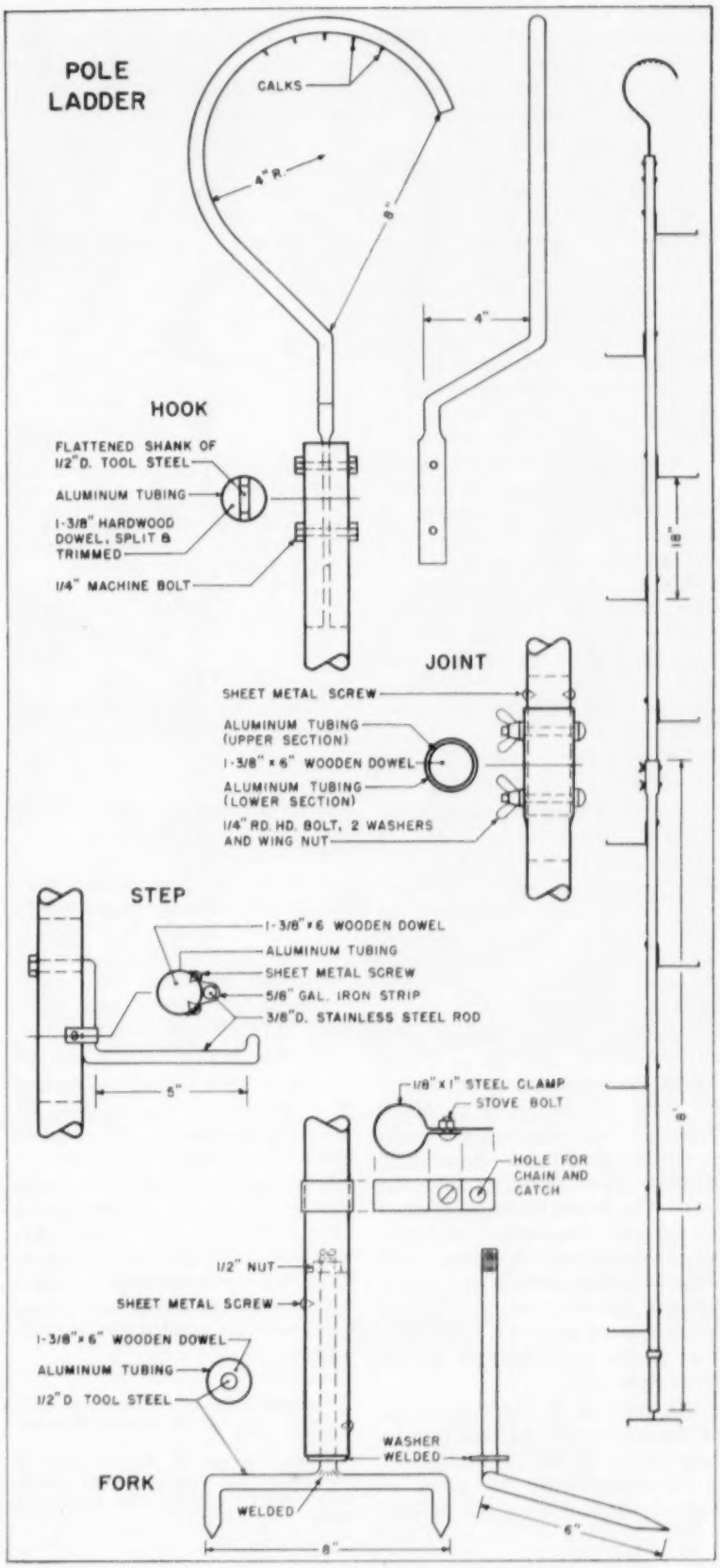
Basically, the ladder is of the hanging type (Fig. 1). At the top is a nonslip hook which is placed over a limb. The hook is so designed that when placed over the base of a limb it holds the upper portion of the ladder about 4 inches away from the bole. Two easily joined 8-foot lengths of aluminum pruning pole, having alternate steel steps protruding from the sides, form the body of the ladder. At the base is a steel fork device and a length of light chain. The fork holds the ladder away from the tree and the chain, when wrapped around the bole, prevents the ladder from swinging. Weight of the ladder is 14 pounds.

The ladder can be carried most easily on the shoulder while walking. For climbing, the hook is placed over a limb, the spikes on the fork at the bottom are driven slightly into the bark with the back of a hatchet or other striking tool, and the chain at the bottom is secured tightly around the tree.

As constructed, the ladder has little tendency to bend towards the tree as you climb it; but a similar longer ladder would probably have greater tendency to bend. This tendency could easily be overcome by attaching at a right angle to each joint of the pole a stiff peg about 4 or 5 inches long to hold the ladder out from a tree so that a climber's feet would have room on the steps.

The central pole is made from two 8-foot sections of commercially manufactured special aluminum alloy handle for a pruning saw. To make the joint for the body of the ladder, the lower length of aluminum pole has one end expanded to slip easily over a non-expanded end of the upper length. The two sections are secured with ¼-inch bolts and wing nuts. They can be quickly detached for transporting or storage. The non-expanded end of the joint is fitted with a wooden plug to prevent the tube from collapsing under extended use.

To keep down weight ⅜-inch round rod was desired for steps because it appeared to be the smallest rod that would provide the



necessary strength. Type T 416 stainless steel, heat treated in a furnace for stiffness and toughness to Rockwell 25 RC was recommended to us. Steps were heated to proper temperature with oxy-acetylene torch and bent to shape, then threaded before being heat treated. Proper bending and heat treating temperatures for any material used should be carefully investigated. A piece of rod about 12 inches long was needed for each step. The nut securing each step to the pole was punched in several places with a center punch to lock threads with the step. In order to minimize injury to the climber if he should slip or fall, the upturned outer end of each step was rounded. Steps were placed 18 inches apart on the pole alternately right and left, and the aluminum tubing was reinforced at these points with 6-inch pieces of 1⅜-inch wooden dowel. A ⅝-inch wide strip of galvanized sheet metal was bent over the lower vertical portion of each step and fastened to the pole with two sheet metal screws in order to prevent the step from swinging.

Because of workshop limitations, ½-inch diameter tool steel was used for the hook at the top of the ladder. Several shallow holes were bored in the inside top portion of the hook to accommodate pieces of ⅛-inch drill rod which were positioned and brazed in place. These calks protrude $\frac{3}{16}$-inch and have been ground to blunt points. For our timber the hook has an 8-inch throat, but this could, of course, be made smaller, and therefore lighter, where only smaller limbs would be encountered. Material of smaller diameter might also be used. The lower, straight portion of the hook was heated and flattened to ¼-inch thickness, and drilled to take two ¼-inch bolts. Spacers made from a 1⅜-inch wooden dowel keep this lower portion of the hook centered in the aluminum tube.

Construction of the fork device at the bottom of the pole can be seen clearly in the illustration. It could undoubtedly be made of lighter material than the ½-inch rod used for the original. Galvanized steel sash chain binds the fork to the tree. An eccentric catch, modified from a type often found on tire chains, tightens the chain.

At Blacks Mountain Experimental Forest, the special ladder has changed the problem of ascending short distances up trees from a difficult and often time-consuming task to an easy and quick one. It has also made the job safer.

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Forest Service, U. S. Department of Agriculture

[1] S. A. Corey, in the shop of the School of Forestry, University of California, Berkeley, devised many assembly techniques and put the ladder together.

[2] Maintained in cooperation with the University of California, Berkeley.

Fernalds Oak

Natural occurrences of *Quercus* × *fernaldi* Trelease (*Q. rubra* × *Q. ilicifolia*) have been reported from only a few localities since the first specimen was described at Bedford, Massachusetts in 1908.[1] Palmer lists other occurrences of this hybrid at Sharon and East Walpole, Massachusetts and on Little Stoney Mountain, Madison County Virginia.[2] Since the two parents are so seldom associated it is possible that the natural occurrence of *Q. fernaldi* is in fact rare.

In view of the few reported localities for this hybrid the finding of a specimen in central Pennsylvania is noteworthy. The tree is located in Centre County and in Compartment 8a of the Farm Woodlands of the Pennsylvania State University. Dr. Donald Wyman has compared herbarium material and acorns from the specimen with material at the Arnold Arboretum and has verified the identification.

[1] Trelease, William. The American oaks. National Academy of Science Memoirs, Vol. XX, 1924.

[2] Palmer, Ernest J. Hybrid oaks of North America. Journal of the Arnold Arboretum, Vol. XXIX, No. 1, January 1948.

The single tree is composed of three stems, two 6 inches and one 8 inches at d.b.h. and though it is 34 feet tall, the form bears some resemblance to that of *Q. ilicifolia* Wangenh. The five lobed leaves resemble *Q. ilicifolia* in appearance, though not so tomentulose beneath, and the fruit is similar to small acorns of *Q. rubra* Michr. Increment borings indicate the tree to be about 30 years of age.

It is interesting to note that one of the parents, *Q. rubra*, is not found in the immediate vicinity of the specimen, the nearest known occurrence being fully a quarter of a mile from Compartment 8a. Palmer suggests that in such cases the parent may have been a single individual which has disappeared from the site.[2] The presence of some of the natural associates of *Q. rubra* on this particular site give strength to this suggestion.

HENRY H. CHISMAN
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Determination of the Age of Tamarack Twigs and an Indication of Aborted Twig Elongation

During the course of research on the larch sawfly (*Pristiphora erichsonii* [Htg.]) in 1954 it became necessary to count and measure 1953 twigs of tamarack (*Larix laricina* [Du Roi] K. Koch). Twig color proved to be a poor criterion of age, and the simple expedient of counting the number of terminal bud scars along the stem did not suffice because, in many instances, no shoot elongation occurred in 1953. However, an accurate way of determining twig age easily and quickly was found in the external structure of the lateral buds and the leaf-bearing spurs.

A current twig can be identified readily by the occurrence of single needles and small subglobular lateral buds (*A*, Fig. 1). These buds open the following spring, each forming a spur bearing a false whorl of deciduous leaves (*B*, Fig. 1). The next season the tiny bud inside this spur opens and another

false whorl of leaves is produced. The new bud scales can be distinguished readily from the previous year's scales by the appearance of a ring between them (*C*, Fig. 1). Another ring is formed in each additional year that the spur produces leaves. Therefore by adding one to the number of rings around a spur the age of the twig can be determined.

With a decline in tree vigor, seasonal elongation of terminal shoots may not occur in tamarack. This condition arose among the trees in a larch sawfly study plot located near Laporte, Minnesota, in 1953. As a result of several successive complete defoliations, shoot production was reduced considerably. Since the larch sawfly is dependent upon current shoots for oviposition sites, the sawfly population declined and subsequent defoliation was only moderate. Apparently the remaining foliage was sufficient to restore the trees' vigor in 1954; branch samples indicated shoot production had risen to compare with that in 1952. Since the 1954 shoots arose from what appeared to be 1952 growth, it was difficult to distinguish between 1952 and 1953 shoots. It soon became apparent that twig color could not be used with certainty to separate the age of twigs.

During an examination of twigs it was found that a peculiar formation in the form of a ring sometimes occurred between the 1952 and 1953 bud scales following the 1952 growth (*D*, Fig. 1). It is reasoned that this ring was formed when the 1952 terminal bud opened in 1953 but produced only leaves and another bud. In 1954, however, the 1953 terminal bud elongated producing a normal shoot directly, as it were, from the 1952 shoot. The ring left between the two-year-old shoot and the current shoot was readily observed, and the age of the older twig was corroborated by the external structure of its lateral spurs which showed only one ring. With normal shoot elongation no ring appeared in the terminal bud between the 1953 and 1954 growth (*E*, Fig. 1).

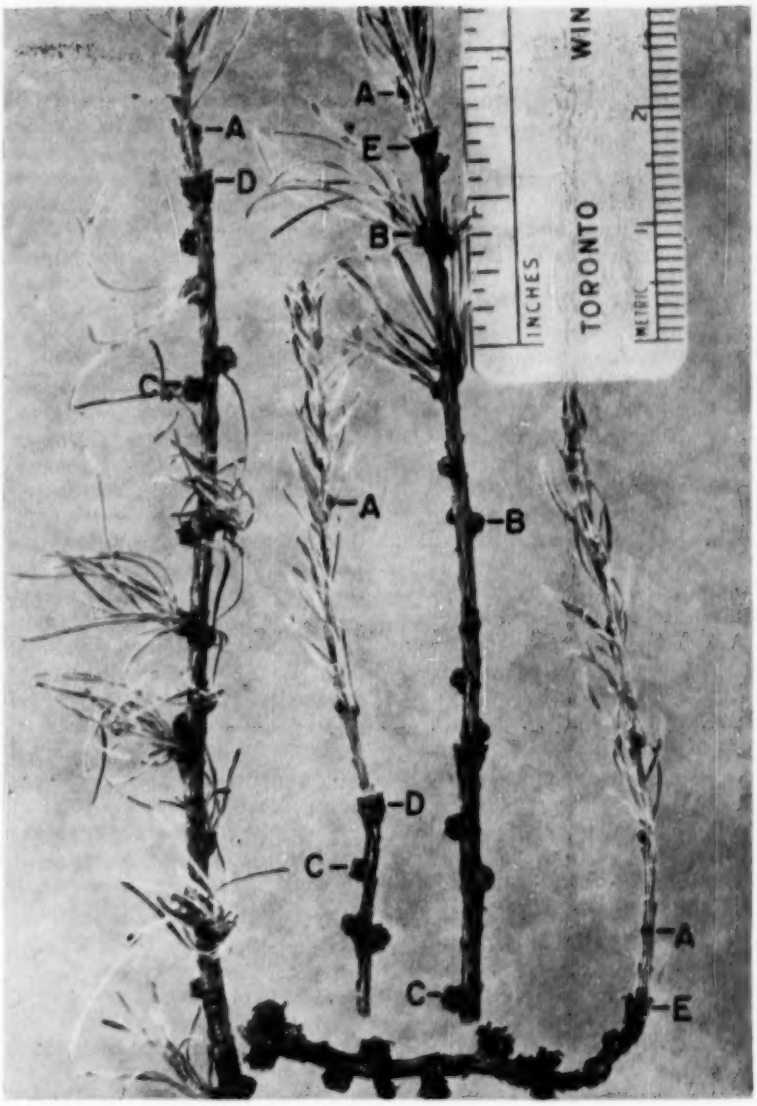

FIG. 1.—Showing the indicators of age and aborted twig elongation. *A*—Current lateral buds. *B*—Start of lateral spur on one-year-old twig. *C*—Two-year-old lateral bud showing the ring indicating its age. *D*—Ring indicating aborted twig elongation in previous season. *E*—Normal terminal bud of previous season.

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Points of View

Farm Management for Foresters

The Forest Service's 1948 reappraisal report clearly brought out the importance of and the need for improved practices in farm woodlands. It pointed out that farmers represent fully 75 percent of all small forest owners, constituting the largest single category of commercial forest landowners in the United States, with aggregate holdings of around 139 million acres. The report also pointed out that only 4 percent of the cuttings applied to farm woodlands were classed as the type of cuttings that would tend to build up the quality and stocking of the stand. At the other extreme, 73 percent of all cuttings on farm woodlands were classed as poor or destructive.

Despite the need for improving the practices applied to farm woodlands our forestry schools have made little effort to implement their curricula to prepare foresters to meet the problem. As a result, foresters having been subjected to four or more years of instruction in a technical forestry school fail to see the place of the farm woodland in the overall farm picture. We tend to overemphasize the woodland, consequently, when attempting to obtain better woodland practices on farms we tend to set our standards to maximize returns from the forest. This is not, nor should it be, the only way the farmer looks at his woods. He is interested in maximizing his return from the farm as a whole, not from one enterprise only. This entails an understanding of the combination of all the productive agents and enterprises on the farm. Generally speaking, it means that while the income from all the farm's resources is being maximized the woodland may be managed at a level of intensity lower than what the forester deems most profitable. This lack of a better understanding of the entire farm operation tends to weaken the forester's position with the farmer, thus making his work less effective.

Therefore, to offset this gap in a forester's training, it seems desirable to incorporate a course in farm management, taught by farm managers, into the required forestry curriculum. This course would not deal so much with the technical aspects of individual enterprises, but would be designed to broaden the perspective of the forester, giving him a picture of trends, developments, and types of farming. It would also point out to foresters the alternatives a farmer or farm manager must consider in attempting to maximize his overall return through an optimum combination of productive agents and/or enterprises.

The writer feels that such a course or courses would be of considerable value in orienting foresters' thinking in regard to farm woodlands, giving foresters as a group the basis for formulating effective forest policy with respect to farm woodlands. It also would be valuable to the farm forester or extension forester in his direct contacts with the farmer.

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Herman G. Schanche (1895-1955)

Herman Garman Schanche of Rumford, Maine, died April 28, 1955.

A native of Pennsylvania, born January 19, 1895, he was graduated in forestry at Penn State in 1918. Following military service in World War I, during which he was a lieutenant in the Army Air Service, he became chief forester for Abitibi Power and Paper Company Limited in Ontario.

In 1929 he became general manager of woods operations for the company. In that period Abitibi operated nine pulp and paper mills, and managed 33,000 square miles of timberland, one of the largest pulp operations on the continent.

Returning to the United States in 1943, Mr. Schanche was appointed as general manager of woods operations for Brown Company at Berlin, N. H., and of Brown Corporation, its Canadian subsidiary. A year later he became vice president.

In 1953, he left Brown Company to become assistant to the executive vice president for woods operations for Oxford Paper Company of Rumford, Maine.

He was a director of the American Pulpwood Association, active in the American Paper and Pulp Association, and a Member of the Society of American Foresters.

A two-page biographical sketch of Mr. Schanche, written by C. S. Herr, was published in the JOURNAL OF FORESTRY for January 1949.

Reviews

Forest Science: A Quarterly Journal of Research

Vol. I, No. 1. Edited by Stephen H. Spurr. 80 pp. Illus. Society of American Foresters, Washington 6, D. C. 1955. $6 per year.

This first issue of FOREST SCIENCE is one more step in the development of American forestry to the stature of a profession in the truest sense of the word. The literature of any profession has to deal with technologies, with social relationships, and with administrative procedures. It needs also to deal with research, for the conduct of productive research and publication of its results are essential to continued growth of the profession.

Up to now these needs have been admirably met by the JOURNAL OF FORESTRY. With the increasing magnitude and stature of forest research, however, there needs to be a special place for the publication of the results of original research. The result is our new FOREST SCIENCE journal.

As indicated by E. L. Demmon, president of the Society of American Foresters, in the lead article of the first issue, "With this initial issue, FOREST SCIENCE is now launched on what should be the beginning of a long and distinguished career in the field of technical forestry publications. . . The pages of FOREST SCIENCE will be opened to all qualified contributors. Preference will be given to papers devoted to the presentation and discussion of the results of original research. Reviews of both foreign and domestic books will be carried."

In general, this reviewer believes that the first issue has made a good start toward the objectives of the journal FOREST SCIENCE. While the published articles vary in character and content, they seem to have a common element of original thinking and good technical quality. It would appear, that some would have been suitable for publication in the JOURNAL OF FORESTRY: they are short in length, and quite practical in their applicability to current forestry technologies. Accordingly, it is hoped that there will be a progressive tendency for authors to submit their shorter contributions on applied science to the JOURNAL OF FORESTRY, and to direct their longer and more fundamental papers toward FOREST SCIENCE.

The make-up of FOREST SCIENCE is attractive. As compared to the JOURNAL OF FORESTRY, the smaller format and the general arrangement and typography of the text are better suited to a scientific periodical. At least in my own first copy, the quality of printing was not good. Some pages are blurred and others are excessively black; and even the type size is undesirably varied. But these are minor faults which will doubtless be remedied in future issues.

As suggested by Mr. Demmon, the journal will need the wholehearted support of organizations and individuals engaged in, or vitally interested in the field of forest research. FOREST SCIENCE will provide an extremely useful reference for workers in this general field, and it should gain greatly in prestige and usefulness as the years go by. May it have a long and successful life!

HAROLD G. WILM
College of Forestry, State University of New York, Syracuse

See the July issue of the JOURNAL for an announcement of the availability of

Forestry and Related Research in North America

Prepared by Frank H. Kaufert, project director, and William H. Cummings, project forester, for the Society of American Foresters Forestry Research Project, this book reports on a study made under the general supervision of a steering committee of the Society and the National Research Council.

The Biltmore Story

By Carl Alwin Schenck. 224 pp. Illus. American Forest History Foundation, St. Paul 1, Minn. 1955. $3.95.

And what an amazing story it is as Dr. Alwin Schenck tells briefly, frankly, and many times humorously, his experiences as a forester in America through the years 1895 to 1915. The setting of the story is mostly in and around Biltmore, North Carolina, the forested estate of George W. Vanderbilt. But there were jaunts into every forest region of the United States and Canada, and contacts with innumerable men of prominence, wealth, and power, as well as with the workers of the forest everywhere.

The story begins, as it should, by presenting some facts about the son of a prominent family in Darmstadt, Germany, who desired very much to be a forester. His university days are passed over briefly except to note that because of a casual experience he learned to speak some English. Undoubtedly, because of that ability he was requested to help guide English and Indian boys through the forests of Europe as assistant to the inspector general of the Indian forests, who incidentally was probably the best known forester in the world at the time, Sir Dietrich Brandis. Later Schenck was graduated from the University of Giessen as a forester and with the degree of doctor of philosophy, a rare article indeed.

But there was a chapter before this in America. Mr. Vanderbilt, no doubt under the suggestion of Frederick Law Olmstead, Sr., the great landscape architect, had the idea of practicing forestry on a private estate and making it pay. Mr. Pinchot had just recently come back from Nancy, France, where he had studied some forestry and met some of the prominent foresters of France and Germany. Mr. Vanderbilt employed Mr. Pinchot to start the work. For some reason this association did not last long and Vanderbilt offered the position to Schenck.

Dr. Schenck came to America in April 1895 and took over the management of Vanderbilt's forest estate. He tells in a fascinating way of the people he met, and of the forest conditions so different from what he had been accustomed to at home. And most interestingly does he tell of the economic factors to be dealt with in any plan to make forestry in a chaotic forest pay. Frequently, throughout the story he sets forth the fundamental principles upon which the management of any forest investment must be based. And it was his frequent restatement of these principles which got him into hot water with Pinchot, Fernow, and others of the early forestry leaders of America.

One of the outstanding factors of his program was the unique school of forestry which he founded. It was the first school of forestry in America and did much to meet the country's need for foresters, a need recognized for over twenty-five years.

In time, when Mr. Vanderbilt found it necessary to discontinue his forestry activities the school continued by establishing points of contact in many of the lumbering regions where the students came to know forest management not only in accordance with theory of growing and marketing forest products but, more important, where they learned the hard facts of American economy. The Biltmore school continued to the end of 1913 when Dr. Schenck went home to Germany discouraged because of the few students who enrolled and because he could see little in the way of "conservative forestry" ahead in this country.

The Biltmore Story describes the early days of forestry in America as only Dr. Schenck could describe them. He was always picturesque in his actions and in his speech. He was an enthusiastic forester. He enjoyed life. Don't fail to read *The Biltmore Story*. He will hold your attention just as he did that of his students in the classroom or in the woods.

GEORGE H. WIRT
Camp Hill, Pa.

A Field Guide to Animal Tracks

By Olaus J. Murie. 374 pp. Illus. Houghton Mifflin Co. Boston. 1954. $3.75.

"What animal made this track?"

"Which rodent g n a w e d this branch?"

"What creature is that?"

Foresters, their families, and friends often ask such questions. This book gives the best answers.

Earlier books on animal tracks have been enjoyed. Seton enriched his many writings with word descriptions and drawings of tracks he had seen during long years of advanced outdoor living. But Seton's clues to track identification were strewn through many pages and volumes. Brunner's 1909 *Tracks and Tracking*, one of Outing Publishing Company's excellent handbooks, was for years the standard reference, but has long been out-of-print, and did not attain the excellence of Murie's new book. Jaeger's *Tracks and Trailcraft*, one of Macmillan's Olympic editions replacing the old Outing handbooks, is a beguiling volume, but its coverage of North American animals, birds, and reptiles is diluted with Indian lore and barnyard and zoo animals, and is less detailed than Murie's new guide.

A Field Guide to Animal Tracks is the culmination of a lifetime of assiduous and inspired study of North American wildlife. Furthermore, it exceeds its title. It really is a field guide to animal identification, for it not only shows typical tracks in dust, mud, and snow, but pictures droppings or sign, the manner in which squirrels gnaw nuts, and each creature in a typical pose and setting. Drawings are by the author in characteristically faithful and understanding detail. Information includes facts seldom recorded in previous literature, and argued about even by those with much wildlife and outdoor experience. The book is one of the occasional rare productions possible only when a skillful, painstaking, expert combines many years of preparation in the field with great writing ability and artistry, and an unsurpassed economy of space and delineation. Few ever possess the knowledge and ability to produce books of such worth.

Dr. Murie's many years as a biologist with the Fish and Wildlife Service, his prize-winning book, *The Elk of North America*, his authentic illustrations sought by writers of other wildlife books, and his leadership of the Wilderness Society and other organizations accepting responsibility for wildlife and wildland welfare, indicate briefly how eminently prepared he is to write this book.

The book gains usefulness from its small size as one of the Peterson Field Guide Series. (Its inclusion within this series also attests its worth.) It is small enough for the pack, pocket, brief case, or glove compartment. Its low price is noteworthy. Its consistent, page-to-page attractiveness makes it charming to own and peruse. But it may be a poor book to lend.

J. V. K. WAGAR
Colorado A & M College

Proceedings of Society of American Foresters 1954 Meeting

Arthur B. Meyer, Editor. 210 pp. Illus. Society of American Foresters, Washington, D. C. 1955. $4.

Held in Milwaukee, Wisconsin, October 24-27, the 1954 annual meeting of the Society of American Foresters attracted an attendance of some 800 members, their ladies, and guests.

In the opening general session and 11 technical sessions, 88 papers were presented, mostly in keeping with the meeting's theme "Our Changing Forests."

The format of this *Proceedings* is identical with that of the JOURNAL OF FORESTRY. Because of the large page size, each with three columns of type the publication is not heavy or bulky. Actually, however, it contains more than 200,000 words, the equivalent of two large books.

The format of the *Proceedings* will permit its being bound with the current volume of the JOURNAL and it is planned to index its contents along with that of Volume 53 of the JOURNAL.

Our National Forests

By Bernard Frank. 238 pp. Illus. University of Oklahoma Press, Norman, Okla. 1955. $4.

Not since the late William DuPuy's *The Nation's Forests*, published by Macmillan in 1938, has there been an authoritative book exclusively about the national forests. Bernard Frank's work thus fills a need for an up-to-date accounting of our 148 national forests, which with their area of 180 million acres constitute one of the greatest natural resource assets this nation or any other nation has ever possessed.

A longtime career officer of the Forest Service, Bernard Frank writes about the national forests from the advantage of intimate knowledge. At the same time he treats the subject with a certain objectivity which is possible because he wrote the book while on leave or not engaged on official Forest Service duties. Hence, the views expressed are his own and do not necessarily reflect the policies of the U. S. Department of Agriculture. In the main, he finds much to commend and little to criticize, which is understandable in an author loyal to an organization noted for the loyalty of its personnel.

As it should be, the volume is strictly factual, but the author has happily interpreted facts and statistics in terms of the human element—the people who manage, and the people who use, these forests. In particular, the chapter "Ten Thousand Loyal Servants" is a tribute to the Forest Service family that is as complimentary as it is deserved.

This work is definitely not a description of each national forest, though the salient data for each forest are given in the appendix. Rather it is a summation, and a skillful one at that, of all that the national forests are in terms of their individual attributes—soil, trees, grass, water, minerals, wildlife, and scenery. That their economic importance is tremendous is attested by the estimate of annual values in services and products (cash and noncash) of 412 millions of dollars. As is well known, the nonrevenue producing values of these properties (soil and water conservation, wildlife habitat, recreation, free products to local residents) account for the greater part of the national forest wealth.

But it is with the contributions of the national forests to society at large that Bernard Frank is mainly concerned, and these he discusses at length in a chapter felicitously entitled "Profit, Pleasure—and Something More." A wilderness enthusiast, he is effective in transmitting the indefinable "feel" of solitude and inspiration, but no less effective in explaining the impact of research on forest management. His discussion of that often misunderstood term "multiple use" is refreshingly original as well as informative.

The briefest chapter "Questions for the Future" is also the most provocative. As the national forests become more essential for wood, forage, water, recreation, and other benefits, inevitably will come increased competition by users, political influence to obtain preferment, and similar pressures on the Forest Service. Indeed, such pressures have existed for years; they are now simply more intense.

The average citizen—our mythical man in the street—knows little about the national forests, frequently confusing them with national parks and other public lands. But he has a valuable stake in the national forests and their management, and this book will help him better understand what they are, what they're for, and why they are important to his welfare.

Justice William O. Douglas contributed the foreword. It is a handsome book, handsomely illustrated. The typography is excellent.

Mr. Frank is co-author (with Anthony Netboy) of *Water, Land and People* published by Knopf in 1950.

HENRY CLEPPER

The Story of FAO

By Gove Hambidge. 303 pp. Illus. D. Van Nostrand Company, Inc., New York 3, N. Y. 1955. $6.50.

The Story of FAO is the fruit of a happy and rare combination: a tale of a fundamental movement deep and broad as humanity itself, and a skilled and sympathetic narrator to give that story life. It is a tale of successes and defeats, of patient preparations, of disappointments, and of obstructing national jealousies, but always of a dogged, unconquerable march toward that far-off goal—the conquest of want. It is a story splendidly told and beautifully illustrated.

Few of the United Nations Organizations are likely to be so fortunate in their historians as the Food and Agriculture Organization, for no one could be better equipped to tell its story than Gove Hambidge, trained writer, acute observer, and leading participant in helping formulate the ideals and direct the structure which is today FAO.

In this book, as in no other single source, the forester may find a picture of the activities and studies in his own field of FAO throughout the world.

This emphasis on current activities necessarily makes impossible any detailed historical background of the individual disciplines that form the structure of FAO. So those foresters who were close to the formative days of FAO may miss the story of the developments that accompanied the belated inclusion of forestry. For the founders of FAO had apparently given no thought to forestry as a major tool in improving human living, and Hambidge tells how President Roosevelt himself proposed its inclusion, with the result that after some reluctance the decision was made to include a Division of Forestry and Forest Products. Foresters may find here a depressing commentary: if men such as the creators of FAO show no realization that forestry and the stabilization of forest soils are indispensable to world agriculture, we have

somehow failed to drive home a basic role of forests.

It was probably inevitable too that space did not permit Hambidge to mention the small, distinguished group of foresters from many countries which, under the leadership of Henry Solon Graves, drew up the blueprints later to serve as a guide for the forestry division, and created, in its *Third Report to Governments*, a statement that has been called "the Magna Carta of forestry."

Yet the foresters of the United States can well be proud of the part played by Americans in those early days. It was F. D. R. who made forestry in FAO possible; it was the worldwide prestige of Dean Graves that to a very large extent brought breadth and a sense of professional integrity to the concept of forestry's place in the battle against want. Lyle Watts, then chief of the U. S. Forest Service, and Walter Lowdermilk were among the Americans who gave unstintedly of their time to help set a true course for forestry in FAO, and today I. T. Haig and M. B. Huberman in Rome are making their own substantial contributions toward the fulfillment of forestry's high purpose.

The theme of FAO itself expresses an aspiration old as mankind—the idea of freedom from want—and to tell its story Hambidge divides his book into three sections. The first gives a vivid and touching picture of a small Egyptian farmer and then contrasts his lot with the status of an average American farmer enjoying the advantages brought to agriculture by the industrial revolution and by educational programs and opportunities. Here Hambidge deals with world factors to show the enormous forces which could work for and against freeing the world's people from hunger and from consequent lack of comfort and health, and to show that no one country or people could deal alone with such problems.

Part II has to do with the genesis and development of FAO, taking the reader back to the early League of Nations days, when a few practical dreamers, fired with the possibilities of international effort, induced the Assembly of the League to declare that human nutrition had an important bearing on world agricultural problems. The importance of nutrition and of agricultural production during World War II served to highlight this concept, and led to the calling of the first Conference on Food and Agriculture at Hot Springs, Va., in 1943. This body was the direct ancestor of FAO.

Section III, which occupies the greater part of the book, deals with technical cooperation, and is an account of the ways in which FAO, through regional projects and work in individual countries, has dealt and is dealing with activities to breed better agricultural plants, to combat diseases of animals and humans, to encourage reforestation and forest management, and to bring about a host of other practices designed to accomplish the ends of FAO.

As source material for understanding the work of FAO the book is unrivaled. But it is something more valuable and far more difficult to attain—it is the dramatization, the bringing to life of the tremendous concept that lay behind FAO's creation and that today gives global status to its battle against hunger and want.

TOM GILL

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Mull and Mor Formation in Relation to Forest Soils

By W. R. C. Handley. 115 pp. Illus. H. M. Stationery Office, 423 Oxford Street, London, W. 1, England. 1954. 10s.

One of the most important segments of silviculture, forest humus has a primary role in directing the course of natural regeneration; it serves as a storehouse for nutrients necessary for tree growth; it influences the susceptibility of forest stands to fire.

The author considers the previous observations of other workers investigating humus formation, and discusses the factors which have a bearing on the synthesis of the two biologically distinct types of forest humus described nearly three-quarters of a century ago by P. E. Müller—*mull* and *mor*. Such factors include the soil parent material, climate, topography, debris and litter, decomposition processes, and the populations of flora and fauna found in humus layers. The author concludes that apparently there is no "acceptable mechanism which might be considered responsible for the differential development of mull and mor humus."

It appears, however, that the type of humus which is formed under any specific set of conditions is governed to a considerable degree by certain characteristics of the vegetable debris. These characteristics are described in the results of a five-year study concerned with the properties of humus. The author sets forth the proposition that a primary cause of differential mull and mor formation is the stabilization of proteins in the dead leaf brought about by tannin-like compounds. These stabilized proteins occur in the mesophyll tissues and, in the case of mor-forming species, are so extremely resistant to biological decomposition that the debris accumulates on the soil surface. In addition, the decomposition of other tissues, not protected by the stabilized proteins, may be delayed considerably because of a lack of nitrogen.

The same process also occurs in mull-forming vegetable debris but the material is not nearly as resistant to breakdown and decomposes readily. Experimental evidence in support of this hypothesis is presented. The mechanism has considerable merit and represents an important contribution to the understanding of humus layers. Like any biological process, however, differential mull and mor formation is extremely complex and results from the interaction of a large number of factors. Using the author's hypothesis alone, for example, it would be difficult to explain humus development under beech which may give rise to mull under some conditions and to mor under other conditions.

This bulletin should be of great

interest to all foresters and soil scientists concerned with humus formation.

G. K. VOIGT
Yale University

Publications of Interest

A list of more than 100 aids to the interpretation of aerial photographs has been published by the Lake States Forest Experiment Station, under the title *Photo-Interpretation Aids,* Miscellaneous Report No. 38. The devices have been developed in many parts of the United States and Canada. The list was assembled by Clarence D. Chase of the Station, and Stephen H. Spurr of the University of Michigan.

The list, a revision of one published in 1948, is limited to relatively inexpensive items such as area measurement aids, linear and multiple use scales, and parallax devices. It also includes various types of stereoscopes. The list provides a brief description of each item and its use, and indicates where it may be obtained and the price, without implying recommendation.

Copies may be obtained from the Lake States Forest Experiment Station, St. Paul Campus, University of Minnesota, St. Paul 1, Minnesota.

* * *

Forest Resources of the Cumberland Lake-Flin Flon Area presents statistics of growth and volume on nearly 18,000,000 acres of Saskatchewan forest. This is the fourth in a series of inventory reports by the Forestry Branch, Department of Natural Resources, Province of Saskatchewan.

Besides the statistical data contained in this report, many interesting facts about the history and settlement of the area are given.

Despite the high potential of forest products—590 million board feet of saw timber and over 5½ million cords of pulpwood—forest industries, with an annual production value of $159,000, play but a secondary role to mining.

Not only is the area commendable from the standpoint of forest wealth, but also from that of recreation. Climate, geology, and drainage of the 2-million-acre area are also well described in this attractive inventory booklet which the layman, as well as the technical forester, should find well worth reading. It may be obtained free of charge from the Forestry Branch, Dept. of Natural Resources, Prince Albert, Sask.

Carl A. Schenck (1868-1955)

Dr. Carl Alwin Schenck, 87, founder of the Biltmore Forest School, and for more than half a century one of the world's well known foresters, died in May in Lindenfels, Germany, after a long illness.

Born March 25, 1868 at Darmstadt, Germany, Dr. Schenck came to the United States in 1895 to take over the management of the woodlands of George W. Vanderbilt in North Carolina.

Among his contributions to American forestry are founding the Biltmore Forest School, preparing a set of forestry textbooks (among the first written for American students), successfully experimenting in reforestation on the Biltmore Estate, and the invention of the "Biltmore Stick," a familiar measuring tool of foresters.

His memoirs, *The Biltmore Story—Recollections of the Beginning of Forestry in the United States,* were published earlier this year by the Minnesota Historical Society for the American Forest History Foundation, and are reviewed elsewhere in this issue. For a time the Biltmore Forest School flourished, but it began to wane about 1910, and in 1913 Schenck admitted it had failed for lack of students. During the nearly 15 years of its life the school graduated between 350 and 400 men.

Despite the fact that he spent most of his active professional career in this country he never became an American citizen. In World War I he served his country as a quartermaster officer on the eastern front where he was wounded in action.

During the 1920's he conducted American and English students of forestry on field tours of German and Swiss forests, and subsequently lectured at various schools of forestry throughout the United States. In 1927 he and graduates of Biltmore tried unsuccessfully to establish a school of lumbering here.

After World War II he made two visits to this country. In 1951 he attended a reunion of the alumni of the Biltmore Forest School at Asheville. On his second visit in June, 1952, he received the honorary degree of Doctor of Forest Science from North Carolina State College.

Current Literature

Compiled by MARTHA MEELIG, *Librarian, State University of New York College of Forestry*

Range Management Section Compiled by FRANCES FLICK, *Library, U. S. Department of Agriculture*

General

Beyond the Cross Timbers; the Travels of Randolph B. Marcy, 1812-1887. By W. E. Hollon. 288 pp. Illus. Univ. of Oklahoma Press, Norman. 1955. $4.00.

First Aid Guide Forest Service, U. S. Department of Agriculture. 57 pp. Illus. U. S. Dept. of Agric., Washington 25, D. C. 1954. 20 cents (Govt. Print. Off.).

In Your Service; the Work of Uncle Sam's Forest Rangers. 24 pp. Illus. U. S. Forest Serv., Washington 25, D. C. 1955. U. S. Dept. of Agric. A. I. B. No. 136.

Minnesota's Wood Pile. 18 pp. Illus. Office of Iron Range Resources & Rehabilitation in coop. with Lake States Forest Expt. Sta., St. Paul, Minn. 1954.

Winter Key to Woody Plants. By A. H. Graves. 33 pp. Publ. by the author, 255 S. Main St., Wallingford, Conn. 1955. $1.35 + 4 cents tax.

Farm Forestry

Christmas Tree Farming. By J. A. Cope and F. E. Winch, Jr. 32 pp. Illus. State Univ. of N. Y., College of Agric., Ithaca, 1954. Bul. No. 704 rev.

Flatwoods Farm Woodland Improvement Pays. By W. H. D. McGregor. 11 pp. Illus. Florida Coop. Ext. Work in Agric. & Home Econ., Univ. of Fla., State Univ. of Fla., and U. S. Forest Serv. 1954. Cir. No. 125.

Forest Economics

Economic Analysis of Farm Forest Operating Units. By S. L. Barraclough and E. M. Gould, Jr. 145 pp. Tables. Harvard Forest, Petersham, Mass. 1955. Bul. No. 26. 50 cents.

Forest Influences

A Guide to Erosion Reduction on National Forest Timber Sale Areas. 78 pp. Illus. U. S. Forest Serv., Calif. region, San Francisco. 1954.

Forest Management

Composite Volume Tables for Timber and Their Application in the Lake States. By S. R. Gevorkiantz and L. P. Olsen. 51 pp. U. S. Dept. of Agric., Washington 25, D. C. 1955. Tech. Bul. No. 1104. 25 cents (Govt. Print. Off.).

A Preliminary Timber Management Plan Ford-Faust-Cheely Property Morgan County, Tennessee. By E. E. Ahler. 11 pp. Tables. TVA, Norris. 1954.

Volume Tables for Maine. Comp. by H. E. Young. 36 pp. Maine Agric. Expt. Sta., Orono. 1955. Misc. Publ. No. 624.

Logging and Milling

An Analysis of Production and Costs in High-Lead Yarding. By M. E. Tennas, R. H. Ruth, and C. M. Berntsen. 37 pp. Pacific Northwest Forest and Range Expt. Sta., Portland, Ore. 1955. Research Paper 11. Mimeog.

Oregon Maple Log and Lumber Grading. By A. C. Wollin and J. R. Pfeiffer. 7 pp. Tables, charts. Oregon Forest Products Lab., Corvallis. 1955. Rept. No. G-4. Mimeog.

Size, Volume, and Weight of Pine Slabs and Edgings in the South Carolina Piedmont. By A. S. Todd and W. C. Anderson. 21 pp. Southeastern Forest Expt. Sta., Asheville, N. C. 1955. Station Paper No. 49. Mimeog.

Protection

Chestnut Weevils; How to Control Them. 8 p. folder. Illus. U. S. Dept. of Agric., Washington 25, D. C. 1955. Leaflet No. 384. 5 cents.

Forest Entomology in Hawaii. By O. H. Swezey. 266 pp. Illus. Bernice P. Bishop Museum in collab. with Hawaiian Bot. Soc. and Hawaiian Ent. Soc., Honolulu, Hawaii. 1954. $4.00.

Forest Insect Conditions in California 1954. 12 pp. Illus. Calif. Forest Pest Control Action Council, Sacramento. 1955.

Forest Plantation Protection Against Diseases and Insect Pests. By J. S. Boyce. 40 pp. FAO Forestry Development Paper No. 3. 1954. 50 cents.

A Summary of Current Forest Pest Problems for New York State 1954-55. Comp . . . by the Committee on Insects and Diseases, SAF New York Section. 1955. Ext. Dept., State Univ. of N. Y. Coll. of Forestry, Syracuse 10. Mimeog.

Range Management

Effects of Some Cultural Practices on Grass Production at Mandan, North Dakota. By J. L. McWilliams. 28 pp. Illus. Supt. of Documents, U. S. Govt. Print. Off., Washington 25, D. C. U. S. Dept. Agric. Tech. Bul. No. 1097. Jan. 1955. 15 cents.

Livestock and Range Research in Montana. 23 pp. Illus. Montana Agric. Expt. Sta., Bozeman. Cir. No. 206. Oct. 1954.

Nutritive Value of Winter Range Plants in the Great Basin. By C. W. Cook and others. 56 pp. Illus. Utah Agric. Expt. Sta., Logan. Bul. No. 372. Sept. 1954.

Range Reseeding in the Ponderosa Pine Zone in Colorado. By A. C. Hull and W. M. Johnson. 40 pp. Illus. Supt. of Documents, U. S. Govt. Print. Off., Washington 25, D. C. U. S. Dept. Agric. Cir. No. 953. Feb. 1955. 20 cents.

Root-growth Stoppage Resulting from Defoliation of Grass. By F. J. Crider. 23 pp. Illus. Supt. of Documents, U. S. Govt. Print. Off., Washington 25, D. C. U. S. Dept. Agric. Tech. Bul. No. 1102. Feb. 1955. 15 cents.

Silviculture

Factors Influencing Height Growth of Planted Yellow-Poplar in Southwestern Michigan. By R. D. Shipman and V. J. Rudolph. 44 pp. Michigan State College, Agric. Expt. Sta., East Lansing. 1954. Tech. Bul. No. 242.

A 4-Year Record of Sitka Spruce and Western Hemlock Seed Fall. By R. H. Ruth and C. M. Berntsen. 13 pp. Illus. Pacific Northwest Forest & Range Expt. Sta., Portland, Ore. 1955. Research Paper No. 12. Mimeog.

The Natural Occurrence of the Eucalypts. 115 pp. Australia Forestry & Timber Bur., Canberra. 1953. Leaflet No. 65.

Thinning in Red and White Pine Stands at Petawawa Forest Experiment Station. By L. A. Smithers. 52 pp. Illus. Canada Forestry Branch, Ottawa. 1954. Silv. Res. Note No. 105.

Wildlife Management

List of North American Recent Mammals. By G. S. Miller and Remington Kellogg. 954 pp. U. S. National Museum, Washington 25, D. C. 1955. Bul. No. 205. $3.50 (Govt. Print. Off.).

Wood Technology and Utilization

Timber Leaflet No. 1-23. By Uganda Forest Dept. (Tree & timber descriptions) Utilization Branch, Forest Dept., P. O. Box No. 1752, Kampala, Uganda.

Use of Bleached Cold Soda Pulps from Certain Mixtures of Latin-American Hardwoods in Newsprint. By G. H. Chidester and K. J. Brown. 8 pp. Tables. U. S. Forest Products Lab., Madison. Wis. 1954. Rept. No. 2013. Mimeog.

The Use of Forest Produce in Sea and River Defence in England and Wales. By J. R. Aaron. 26 pp. Illus. Great Britain Forestry Commission, London. 1954. Forest Record No. 29. 1s.6d. (H. M. Sta. Off.).

Variations in Fibril Angles in Slash Pine. By C. H. Hiller. 4 pp. Illus. U. S. Forest Products Lab., Madison, Wis. 1954. Rept. No. 2003. Mimeog.

Vom Wunder des Holzes. By F. U. Gass and Agnete Baum. 93 pp. Illus. Kleine Verlags-Gesellschaft, Stuttgart, Germany. 1954. $10.00.

Society Affairs

Officers and Council
1954-1955

E. L. DEMMON, *President*
Southeastern Forest Experiment Station
Federal Building
Asheville, N. C.

DEWITT NELSON, *Vice President*
Department of Natural Resources
State Building 1
Sacramento, Calif.

HENRY CLEPPER, *Executive Secretary*
Mills Building, 17th Street at Pennsylvania Avenue, N. W.
Washington 6, D. C.

WILLIAM J. BROWN
Woodlands Department
Kimberly-Clark Corporation
Neenah, Wis.

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Tallahassee, Fla.

PERCY D. HANSON
U. S. Forest Service
Federal Building
Missoula, Mont.

J. HERBERT STONE
U. S. Forest Service
729 N.E. Oregon St.
Portland 8, Ore.

D. B. DEMERITT
Dead River Company
6 State Street
Bangor, Me.

EDWIN F. HEACOX
Weyerhaeuser Timber Company
Tacoma 1, Wash.

RUTHFORD H. WESTVELD
Department of Forestry
University of Missouri
Columbia, Mo.

SECTION BOX SCORE
1955 MEMBERSHIP

Section	Applications received[1] June 1955	Total 1954	Total 1955
Allegheny	3	68	49
Appalachian	1	48	29
Central Rocky Mountain	0	26	5
Central States	1	80	70
Columbia River	14	56	56
Gulf States	15	57	82
Inland Empire	1	39	5
Intermountain	4	14	14
Kentucky-Tennessee	1	5	4
New England	1	54	46
New York	3	40	34
Northern California	2	34	27
Northern Rocky Mountain	2	35	34
Ozark	2	49	22
Puget Sound	8	61	54
Southeastern	3	128	59
Southern California	0	2	3
Southwestern	2	7	10
Upper-Mississippi Valley	7	64	36
Washington	0	7	3
Wisconsin-Michigan	5	11	21
Totals	75	885	663

[1]Student, Junior, Affiliate, Associate (Initial) grades only.

SCHOOL BOX SCORE
1955 MEMBERSHIP

School	Student applications received June 1955	Eligibles[1] 1955	Total 1955
Alabama Polytechnic Institute	0	27	18
University of California	0	46	16
Colorado A & M College	0	63	4
Duke University	0	11	2
University of Florida	0	22	6
University of Georgia	0	65	20
University of Idaho	0	31	3
Iowa State College	3	65	15
Louisiana Polytechnic Institute	0	19	12
Louisiana State University	5	41	30
University of Maine	1	56	16
University of Massachusetts	0	38	8
Michigan State College	0	60	35
University of Michigan	1	46	18
University of Minnesota	3	40	13
University of Missouri	1	32	10
Montana State University	1	98	19
State University of New York	3	99	25
North Carolina State College	0	59	20
Oregon State College	4	81	13
Pennsylvania State University	0	104	35
Purdue University	1	51	25
Utah State Agricultural College	1	28	8
University of Washington	1	88	31
West Virginia University	2	29	9
Yale University	0	29	17
Totals	27	1,328	428

[1]Includes Juniors and Seniors who will be eligible for Junior Membership upon graduation and Graduate students in approved curricula who are not yet eligible for Junior Membership.

The President's Column

E. L. DEMMON

Why is so much forest land in America still inadequately protected from fire? Most of what's been done in coping with forest fires in the United States has been under the direction of our forestry profession. But we haven't accomplished enough, nowhere near enough; actually we have failed in many aspects of fire protection.

I recently made a trip through parts of the Southeast and was appalled at the extensive damage caused by fires during the past few months. Of course, this was an unusually dry spring, and fires burned a larger area than usual. In fact, one single fire in eastern North Carolina burned about 175,000 acres before it could be controlled. I doubt whether there has ever been recorded such a large fire in North Carolina, at least in modern times. And the evidence indicates that this and most fires in the Southeast this spring have been deliberately set.

One of the cardinal tenets of good forestry, as taught in all professional schools of forestry, has been the necessity of adequately protecting forest lands from fire. Over the years great progress has been made in extending protection to unprotected areas, in improving fire-fighting techniques, in fire prevention campaigns. Roadside signs, television, radio, and Smokey Bear have all cautioned the public to be careful with fire and to keep forests green.

Yet with all these efforts, there are still some 50 million acres of commercial forest land in this country without organized fire protection, and many more millions of acres receive only partial protection. Expenditures for forest fire protection by all public and private agencies now total about $70 million annually, whereas the cost of getting the entire protection job done is estimated at close to $100 million.

It's a grave situation, this continuing multitude of fires each year. Let's grant that complete fire exclusion can never be attained. We also recognize that our system of reporting fires has improved. Even so, there has been little reduction in the actual number of fires reported each year for the last 25 years. And most fires, particularly in the eastern part of the country, are caused by human negligence or actual incendiarism!

Why is it that our prevention efforts do not seem to be reaching the people responsible for most of these fires? Here is a real challenge to the forestry profession!

Many people have studied and speculated concerning public psychology and fires. Maybe we have not yet really touched the public mind regarding forest fire. Maybe there are better ways of translating the fire-prevention message into action. We are touching here on some very big and important matters that need additional study.

What has fire research been doing all this time? It is agreed that research has made great progress in adding to our knowledge of fire, methods of predicting fire danger, effects of fire, and methods of control as well as the prescribed use of fire. But research has been inadequately financed to do the job needed. A group of Society members recognized this at our annual meeting in Colorado Springs, Colorado, in October 1953. (Jour. Forestry, Nov. '53, Vol. 51, No. 11, pp. 842-43.) Annual expenditures for fire research by all agencies, including equipment development, come to about $420,000 according to the recent research study made by the Society. This represents less than 1 percent of current fire protection expenditures and less than 1 percent of current fire losses. We have failed to obtain the essential funds needed for fire research as well as for fire protection.

What more can we as a profession do to redeem our responsibilities in so far as protecting American forests from fire is concerned? Primarily, we must somehow get across to the American public the fact that protecting the country's forests from fire is still a major problem and everyone's responsibility. Public laws relating to carelessness with fire and incendiarism must be strengthened and more strictly enforced. More adequate fire research must be provided, including the development of more effective and efficient fire-fighting equipment. Use of aircraft for spotting and control work should be expanded. Studies of human psychology and fire should be made. Every forester should put on a public relations campaign in his own neighborhood to reduce carelessness with fire and incendiarism.

Let us admit that we have failed to meet the goal of adequate forest fire protection in this country and work toward it as a major professional responsibility. We seem to have become complacent about fire losses. Let's all get on the ball and everyone of us do his best to improve the protection of our forests from fire.

E. L. Demmon

Annual Meeting Society of American Foresters Portland, Oregon October 16-19

The fifty-fifth annual meeting of the Society of American Foresters will be held in Portland, Oregon, October 16-19. Headquarters will be the Multnomah Hotel.

The theme of the meeting is "Converting the Old Growth Forest."

The following information should enable members to make advance plans and to request room reservations. Additional information about the program will appear in subsequent issues of the JOURNAL.

Schedule of Events

It is suggested that those expecting to attend the meeting arrive in Portland on Sunday, October 16, or not later than the morning of Monday, October 17. The open meetings start on Monday morning.

As shown by the following schedule of events, numerous meetings and technical sessions have been arranged to provide attractions for a diversity of interests. The August issue will contain the complete program of topics and speakers.

Optional postmeeting field trips will be scheduled for Thursday, October 20, and for Friday, October 21. Details about these trips will be announced later.

Special events are being planned for the ladies, and will be announced in later issues of the JOURNAL.

Saturday, October 15

Council of Forestry School Executives: morning and afternoon.

Sunday, October 16

S.A.F. Council meeting: morning and afternoon.

Committee on Accrediting: afternoon.

Editorial Board, JOURNAL OF FORESTRY: evening.

Joint meeting of Council and Section officers: evening.

Association of Consulting Foresters: evening.

Monday, October 17

Opening General Session: morning.

Society Affairs Session: afternoon.

Division of Private Forestry: evening.

Division of Education: evening.

Division of Public Relations: evening.

Tuesday, October 18

Division of Silviculture: morning and afternoon.

Division of Range Management: morning.

Division of Forest Recreation: morning.

Division of Forest Products: afternoon.

Division of Forest-Wildlife Management: afternoon.

Social evening with Columbia River Section and Puget Sound Section as hosts.

Wednesday, October 19

Division of Forest Management: morning and evening.

Division of Economics and Policy: morning.

Division of Watershed Management: afternoon.

The annual Society Dinner: evening.

October 20 and 21

Field Trips.

Hotel Reservations

The Multnomah Hotel will be the headquarters hotel where most scheduled events will be held. Although the Multnomah contains 600 rooms, it will not be able to accommodate all those in attendance, hence other hotels are cooperating.

A special S.A.F. Housing Committee has been set up for the meeting, and all requests for room reservations should be addressed to this committee, as follows:

Housing Committee, Society of American Foresters; c/o Portland Chamber of Commerce; 824 S. W. Fifth Avenue; Portland 4, Oregon.

The reservation coupon printed herewith may be used. Subscribers who do not wish to cut the coupon from their JOURNALS may request reservations simply by providing the Housing Committee with all the information requested on the coupon.

Each reservation request should indicate first choice, second choice, and third choice hotels. As usual, single rooms may be scarce, hence when possible twin-bed rooms should be used.

There follows a list of cooperating hotels and their rates. All quoted rates are with bath unless otherwise noted. Some hotels have rooms with connecting baths at lower rates.

Hotels

Multnomah Hotel, S.W. Fourth Avenue and Pine Street. Single rooms, $6 to $8; double, $8 to $13; twin beds, $9 to $13. Sets of twin-bed rooms and double rooms connecting, for four people, $15 to $16. Suites available.

Benson Hotel, S. W. Broadway at Oak Street. (Four blocks from the Multnomah.) Single, $6 to $10; double, $8 to $15; twin beds, $11.50 to $15.

Imperial Hotel, S. W. Broadway at Stark Street. (Five blocks from the Multnomah.) Single, $4 to $6; double, $6 to $8; twin beds, $7 to $9.

Congress Hotel, S. W. Sixth Avenue and Main Street. (Ten blocks from the Multnomah.) Single, $5.50 to $7; double, $6 to $8; twin beds, $7.50 to $8.50.

New Heathman Hotel, 712 S. W. Salmon Street. (Eleven blocks from the Multnomah.) Single, $6.50; double, $8; twin beds, $8.50.

In addition to the foregoing hotels, there are other smaller hotels within the downtown area. The Housing Committee will supply a list of these hotels with their addresses for those who request it.

Motels and motor courts are available outside the downtown area. Their rates for single rooms with bath are from $5.50 up; doubles are $6.50 and up. The Housing Committee will make motel reservations, or will furnish members with a list of motels for those who may wish to request their own reservations.

(Continued on page 466)

SOCIETY OF AMERICAN FORESTERS
ANNUAL MEETING
Portland, Oregon. October 16-19, 1955

_____, 1955

Housing Committee, Society of American Foresters,
c/o Portland Chamber of Commerce,
824 S. W. Fifth Avenue,
Portland 4, Oregon.

First Choice Hotel _____
Second Choice Hotel _____
Third Choice Hotel _____

Please make a reservation for the following room accommodations for arrival on October _____, a.m. / p.m. Departure date, October _____.

I understand that accommodations will be provided at the daily rate specified, if available; otherwise the next nearest rate will apply.

_____ Single room with bath. Rate, $_____.
_____ Double-bed room with bath. Rate, $_____.
_____ Twin-bed room with bath. Rate, $_____.
_____ Suite (parlor, twin-bed room, and bath). Rate, $_____.
_____ Other. (Specify accommodations desired.) _____
_____. Rate, $_____.

The above room accommodations are requested for the following persons, in addition to myself. (Print or typewrite names and addresses legibly.)

_____
_____
_____

My name: _____
Street address: _____
City, zone, state: _____

Meeting Committees

The general chairman for the meeting is J. Herbert Stone, U. S. Forest Service, 729 N. E. Oregon Street, Portland 8, Ore.

Assisting him are the following committees and their personnel.

Program Committee

The chairman of the Program Committee is W. F. McCulloch, School of Forestry, Oregon State College, Corvallis, Ore. The other members are K. G. Fensom, Roger Guernsey, Clare Hendee, and A. J. Sandoz.

Arrangements Committee

The chairman of the Committee on Arrangements is Clarence Richen, Crown Zellerbach Corp., 1400 Public Service Building, Portland, Ore.

Assisting him is Laurence C. Jolley, U. S. Forest Service, 729 N. E. Oregon Street, Portland 8, Ore.

Heading up special task committees are the following individuals:

Information and Publicity, Albert Arnst.

Hotel Reservations and Housing, Howard Roberts.

Registration and Welcome, Martin L. Syverson.

Exhibits, Arthur K. Roberts.

Field Trips, Nels Jeffers.

Ladies Entertainment, Mrs. Stuart Moir.

Meeting and Conference Rooms, Owen Cramer.

Annual Dinner Arrangements, Paul Vance.

Projection and Amplifying Equipment, Clyde Stratton.

"Sergeant-at-Arms," Louis Alexander.

Special Assignments, Robert D. Hostetter.

Dues Deadline June 30

June 30 is the deadline for the payment of 1955 Society dues. Members whose dues are not paid by this date will be in bad standing and will be ineligible to vote, receive the Society's publications, or be a candidate for office until their dues are paid. In cases of financial stringency the Council may upon request extend the period during which current dues may be paid.

Prompt payment is mutually advantageous since it helps the Society in budgeting income and expense and assures delivery of Society publications to members.

Fourth Call for Fellow Nominations

All Members (formerly Senior Members) and Fellows of the Society are hereby advised that nominations for the grade of Fellow are now open. The election of Fellows will be held at the time of the Society's regular biennial election, December 3, 1955.

As defined by the Constitution (Article III, Section 6), "Fellows shall be foresters of outstanding achievement as leaders in responsible directive or distinctive individual work of a fruitful character. They shall be elected from the Members and shall be engaged in forestry work at the time of their election."

Nominations by Petition

The procedure for placing Members in nomination for the grade of Fellow is by petition. The Society has no printed form for this purpose; the petition may be typewritten thus:

We, the undersigned Members and Fellows of the Society of American Foresters, hereby nominate _____ for election to the grade of Fellow in 1955.

Remember these simple rules:

1. A petition may not name more than one candidate.

2. It must be signed by 25 Members or Fellows in good standing.

3. It should be accompanied by a factual, not eulogistic, biographical sketch of at least 200 words giving an account of the nominee's professional career and accomplishments.

4. It must be received in the executive office of the Society in Washington, D. C., not later than October 1, 1955.

The executive employees of the Society cannot be responsible for obtaining signatures on partially completed petitions or on petitions incomplete by reason of unacceptable signatures (that is, signatures of other than Members and Fellows in good standing).

Nominations Received

Up to the time of going to press, the following nominations had been received.

Samuel B. Detwiler, Boulder, Colo.
James F. Dubuar, Wanakena, N.Y.
Stanley G. Fontanna, Ann Arbor, Mich.
J. Alfred Hall, Madison, Wis.
Frank H. Kaufert, St. Paul, Minn.
F. P. Keen, Berkeley, Calif.

Election Procedure

Fellows are not elected by the membership at large, but by a board of electors which consists of all present Fellows and the present Council. (A Council member who is also a Fellow has but one vote.)

The system is described in Article IV, Section 4 of the Constitution. To win election a candidate must receive an affirmative vote of not less than one-half the total votes cast.

Significance of the Grade

The highest membership distinction that can be conferred by the Society, this grade is awarded in recognition of outstanding achievement. Fellows do not pay increased dues; their dues are the same as those of Members.

Since the Society was founded in 1900, there have been 100 Fellows elected. At the present time the number of living Fellows is 69.

Since the last election in December 1953, two Fellows have died: Elers Koch and E. A. Sterling.

List of Fellows

The current roster of Fellows follows. The state in which each Fellow is domiciled and the year of his election are shown after his name.

Allen, Shirley W. Michigan. 1948.
Baker, Frederick S. California. 1949.
Besley, Fred W. Maryland. 1940.
Brundage, Frederick H. Oregon. 1949.
Butler, Ovid. Maryland. 1940.
Carter, E. E. District of Columbia. 1942.
Chapman, Herman H. Connecticut. 1922.
Clapp, Earle H. District of Columbia. 1930.
Clepper, Henry E. Virginia. 1949.
Coffman, John D. California. 1946.
Cox, William T. Minnesota. 1953.
Curran, Hugh. Venezuela. 1951.
Damtoft, Walter J. North Carolina. 1951.
Dana, Samuel T. Michigan. 1935.
Demmon, Elwood L. North Carolina. 1951.
Drake, George L. Washington. 1953.
Eldredge, Inman F. Louisiana. 1942.
Evans, Charles F. Georgia. 1949.
Evenden, J. C. Idaho. 1953.
Ferguson, J. A. Pennsylvania. 1949.
Fischer, Arthur F. California. 1940.
Fritz, Emanuel. California. 1951.
Frothingham, E. H. California. 1942.
Garratt, George A. Connecticut. 1953.
Gill, Tom. District of Columbia. 1948.
Granger, Christopher M. Maryland. 1946.
Greeley, William B. Washington. 1918.
Guise, Cedric H. New York. 1951.
Guthrie, John D. Virginia. 1942.
Hall, William L. Arkansas. 1940.
Hartley, Carl P. Maryland. 1949.
Hawes, Austin F. Connecticut. 1939.
Hawley, Ralph C. Connecticut. 1942.
Heintzleman, B. Frank. Alaska. 1951.
Holmes, J. S. North Carolina. 1939.
Hosmer, Ralph S. New York. 1932.
Hunt, George M. Wisconsin. 1951.
Illick, Joseph S. New York. 1946.
Isaac, Leo A. Oregon. 1953.
Jeffers, Dwight S. Oregon. 1948.
Kelley, E. W. California. 1949.
Kellogg, Royal S. Florida. 1949.
Kinney, Jay P. New York. 1942.

Kittredge, Joseph. California. 1953.
Korstian, Clarence F. North Carolina. 1942.
Krueger, Myron E. California. 1951.
Lowdermilk, Walter C. California. 1948.
MacDonald, G. B. Iowa. 1944.
Marsh, Raymond E. District of Columbia. 1948.
Martin, Clyde S. Washington. 1948.
Mason, David T. Oregon. 1948.
McArdle, Richard E. District of Columbia. 1953.
Metcalf, Woodbridge. California. 1953.
Morrell, Fred W. Virginia. 1951.
Mulford, Walter. California. 1939.
Munger, Thornton T. Oregon. 1946.
Munns, Edward N. California. 1949.
Preston, John F. District of Columbia. 1948.
Price, Jay H. Arizona. 1951.
Schmitz, Henry. Washington. 1940.
Shirley, Hardy L. New York. 1951.
Show, S. B. California. 1948.
Siecke, E. O. Texas. 1946.
Sparhawk, William N. New Hampshire. 1946.
Watts, Lyle F. Oregon. 1946.
Winslow, C. P. Washington. 1942.
Wirt, George H. Pennsylvania. 1948.
Ziegler, E. A. Pennsylvania. 1949.
Zon, Raphael. Minnesota. 1918.

Fourth Call for Council Nominations

The regular biennial election will be held December 3, 1955. A president, vice president, and nine other members of the Council will be elected for the two-year term 1956-1957.

The present Council is listed in the box on page 463. Any or all of these incumbents may be renominated, provided they accept the nomination in writing.

President Demmon has announced that he will not be a candidate for reelection.

Membership on the Council is restricted by the Constitution to Members (formerly Senior Members) and Fellows. Any Member or Fellow is eligible to hold office who is in good standing and who accepts the nomination in writing and declares his willingness to serve if elected.

Each voter will have an opportunity to ballot on all candidates for office. Council members are elected in accordance with the system of proportional representation. The procedure will be explained in a later issue of the JOURNAL. It is the system by which the Society has been electing Council members for over two decades. Candidates for the office of president are voted on separately; the candidate who receives the highest vote is declared elected president, and the candidate who receives the next highest vote is declared elected vice president.

How Nominations Are Made

The Constitution (Article VIII, Section 2) states the conditions under which nominations are made by petition.

1. Each petition shall name but one candidate.

2. All candidates must be eligible to hold elective office.

3. A petition shall bear the signatures of at least ten voting members who at the time of signing the petition are eligible to vote in the coming election. (Eligible voting members are Junior Members, Members, and Fellows in good standing.)

4. A voting member may not sign more than one nominating petition for President or more than one nominating petition for a member of the Council. That is, he may sign two, but no more.

5. Petitions must be in the Society office by October 1, 1955.

The Society has no special form for submitting nominating petitions. They may be written as follows:

We, the undersigned voting members of the Society of American Foresters, hereby nominate John Doe, a Member (or Fellow) for the office of president (or member of the Council) for the two-year term 1956-1957.

All nominating petitions should be sent promptly to the Society office. The executive secretary will gladly provide information about nominating or election procedure.

(Continued on page 468)

when you MARK TREES The NELSON WAY!

IT'S TRUE—Using Nelson's three way time and money saver—Paint you don't have to stir—Packed in quart cans which screw directly to the NEL-SPOT gun with reversible nozzle that cleans itself—4 quarts of Nelson tree marking paint cost less than the cheapest paint you can buy by the gallon.

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2. **YOU SAVE TIME WITH NELSON QUARTS**—No mixing, stirring, straining, transferring or spilling of paint. No nightly cleaning of guns and equipment. No waste time unplugging guns and trying to make cheap paints work. Foresters report saving of from 10 to 30 per cent of their work day.

3. **YOUR MARKS ENDURE**—Trees marked with Nelson tree marking paint stay marked—eliminating costly re-marking. Nelson paint stays on the surface leaving bright and durable marks which remain visible for years. Can also be used for boundaries.

Yes—IT'S TRUE that 4 Nelson quarts are more economical than the cheapest paints you can buy by the gallon. Quality in paint as in other things—not only pays for itself but saves—because—you use less and you save time, the most important factor costwise. Prove this for yourself—Send your order today or write for free bulletin and prices, Dept. JF-24.

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Seattle 44, Wash.

R. Kirkpatrick
1805 N.E. 141st Ave.
Portland 20, Ore.

Nominations Received

Up to the time of going to press, the following nominations had been received.

For President: DeWitt Nelson, Sacramento, Calif. (Vice president, 1954-1955.)

For the Council: B. E. Allen, Savannah, Ga.; N. T. Barron, Franklin, Va.; C. H. Coulter, Tallahassee, Fla. (Council member, 1954-1955); S. G. Fontanna, Ann Arbor, Mich. (Council member, 1954-1955); E. F. Heacox, Tacoma, Wash. (Council member, 1954-1955); W. P. House, Chesham, N.H.; H. J. Vaux, Berkeley, Calif.

There must be at least two candidates for the office of president, and at least nine candidates for membership on the Council. However, the Nominating Committee has announced that it will make no nominations of its own unless the voting membership fails to make the required minimum number of nominations by petition. Voting members should accordingly get busy and make their own nominations.

ADNA R. BOND, *Chairman,*
Nominating Committee.

Forestry Handbook Scheduled for September Appearance

A meeting was held on April 5 between Society representatives and officials of The Ronald Press Company, New York, relative to the publisher's final plans for appearance of the *Forestry Handbook*. E. W. Littlefield, chairman of the Editorial Committee for the handbook, and Executive Secretary Henry Clepper were accompanied by Arthur Meyer, Society editor, who has handled details of the book's publication since its completion in manuscript by Editor R. G. Forbes.

The publisher exhibited sample pages of text, illustrations, and tables, and a dummy of the book itself. This volume of approximately 1,250 (6 x 9 inch) pages, 290 illustrations, and 480 tables, will have a durable cover of flexible water resistant material. The 23 sections will offer a wide range of subject matter for all who have a professional or commercial interest in our forest lands. The *Forestry Handbook* will be organized to make quickly available the facts, data and working methods of practical forestry and its many related fields.

This complete reference work will be issued in September, 1955, at $15.00, and will be made available to colleges at a special price for classroom use.

PLAN NOW TO
ATTEND ANNUAL MEETING
Portland, Oregon
Hotel Multnomah
October 16-19, 1955

Membership Applications and Advancements

Proposals for admission, advancement, and reinstatements received in the Society office during the month of April are listed below.

Action on the eligibility of those proposed for membership as listed below will be taken by the Council as of July 1, 1955. Communications from voting members regarding the membership eligibility of these persons should be received in the Society office prior to that date.

Allegheny Section

Student Grade
WEST VIRGINIA UNIVERSITY
Gabbert, C. L. Wells, J. H.

Affiliate Grade
Lichtenberger, R. S., Supt., Howard Nursery, Pa. Game Comm., Howard, Pa.

Appalachian Section

Junior Grade
Fast, R. J., Dist. Forester, W. Va. Pulp & Paper Co., Walterboro, S. C.; Pa. State, B.S.F., 1942.
Vass, G. R., Summerville, S. C. Reinstatement.

Member Grade
Page, R. H., Box 27, Pittsboro, N. C. Reinstatement.
Perry, J. P., Calle Londres 45, Mexico, D.F., Mexico. (Junior, 1948).

Central Rocky Mountain Section

Junior Grade
Assmus, C. S., 2571 W. 2nd Ave., Durango, Colorado. Reinstatement.
Fiebelkorn, C., Lake George, Colo. Reinstatement.

Central States Section

Student Grade
PURDUE UNIVERSITY
Hmurovich, M. J.

LITTLE BEAVER TREE GIRDLER and Attachments

Little Beaver Tree Girdler, cuts girdle around tree at walking speed. One man will girdle more acres per day than several men using other methods.

Brush and Pruning Saw attachments to take care of any brush cutting or pruning job, four foot sections may be added to get desired height. Brush saw does the work of several men.

A Post Hole Auger designed for one man operation, doing the work of heavy equipment diggers, holes quickly and easily made in any soil type. Wood auger may be attached for wood drilling.

HAYNES TREE GIRDLER

FOR DETAILS SEE YOUR DEALER OR WRITE:
HAYNES MFG. CO. LIVINGSTON, TEXAS, U. S. A.

Member Grade

Foley, T. A., Yard Supt., T. A. Foley Lbr. Co., Parris, Ill.; Purdue, B.S.F., 1951. (Junior, 1951).

Affiliate Grade

Honchell, V. D., Ohio Div. of Forestry, Athens, Ohio. Reinstatement.

Columbia River Section

Student Grade

OREGON STATE COLLEGE

McCredie, W. H. Smith, D. H.
Quackenbush, C. E. Zimmerman, N. L.

Junior Grade

Anderson, G. W., Forester, U.S.F.S., Oakridge, Ore.; U. of Minn., B.S.F., 1952.

Beatty, R. O., Public Relations Asst., Crown Zellerbach Corp., Portland, Ore.; U. of Mich., B.S.F., 1945; M.S., 1946.

Greathouse, T. E., Dist. Forest Ranger, U.S.F.S., Crescent, Ore. Reinstatement.

Haglund, H. L., Forester, Bur. of Land Mgmt., Medford, Ore. Reinstatement.

Hess, J. A., Engineer, U.S.F.S., Bend, Ore.; Mont. State, B.S.F., 1941.

Hiatt, R. M., Forester, U.S.F.S., Sisters, Ore.; Purdue, B.S.F., 1950.

Howard, V. M., Forester, Portland Mfg. Co., Portland, Ore.; U. of Wash., B.S.F., 1950.

Simons, L. A., 1447 Kingston, Bend, Ore. Reinstatement.

Wahl, J. D., Woodsworker, Weyerhaeuser Tbr. Co., Kelso, Wash.; Iowa State, B.S.F., 1951.

Member Grade

Riley, J. C., Forester, U.S.F.S., Eugene, Ore.; U. of Mich., B.S.F., 1942; M.F., 1951. (Junior, 1949).

Winslow, L. P., Route 1, Philomath, Ore. Reinstatement.

Affiliate Grade

Hebard, K. L., Cruiser, Log-buyer, Sun Studs, Inc., Roseburg, Ore.

Hunt, J. C., Forester, Bur. of Land Mgmt., Portland, Ore.

Jensen, K. W., Forester, Bur. of Land Mgmt., Medford, Ore.; Wash. State, B.S., (Forestry), 1953.

Koelle, P. W., Forester, Bur. of Land Mgmt., Salem, Ore.; U. of Conn., B.S., (Forestry), 1951.

Gulf States Section

Student Grade

LOUISIANA STATE UNIVERSITY

Allee, R. S. Varnado, H. W.
Dalrymple, R. K. Whatley, C. V.
Prescott, J. M.

Junior Grade

Champagne, E. P., Asst. Dist. Forester, La. Forestry Comm., Monroe, La.; L.S.U., B.S.F., 1950.

Larance, C. E., Box 458, Dubach, La.; L.P.I., B.S.F., 1955. (Student, 1955).

Mabry, J. D., 2623 Hazel, Texarkana, Texas. Reinstatement.

Perry, V. K., 333 W. Hickory, Bastrop, La.; L.P.I., B.S.F., 1955 (Student, 1955).

Thompson, C. R., 700 S. Bonner St., Ruston, La.; L.P.I., B.S.F., 1955. (Student, 1955).

Affiliate Grade

Alexander, P. W., Area Forester, Gaylord Container Corp., Walker, La.; Okla. A & M, B.S., (Forestry), 1950.

Arnold, W. A., Asst. Forester, A. DeWeese Lbr. Co., Inc., Kosciusko, Miss.

Davis, O. C., Woodlands Mgr., Gulfport Creosoting Co., Gulfport, Miss.

Maples, W. S., Forester, Pascagoula Hardwood Co., Perkinston, Miss.

Runyon, J. C., Dist. Mgmt. Forester, Miss. Forestry Comm., Rolling Fork, Miss.; Okla. A & M, B.S., (Forestry), 1953.

Wittenburg, D. E., Asst. Forester, Chicago Mill & Lbr. Co., Greenville, Miss.; Ark. A & M, B.S., (Forestry), 1954.

Associate Grade

Henry, B. W., Officer in Charge, Southern Inst. of Forest Genetics, Gulfport, Miss.; W. Va. Univ., A.B., (Botany-Zoology), 1936; M.S., (Plant Path.), 1938; U. of Wis., Ph.D., (Plant Path.-Physiology), 1941.

Snyder, E. B., Geneticist, U.S.F.S., Gulfport, Miss.; U. of Wis., Ph.D., (Plant Breeding), 1950.

Corresponding Grade

VanBuitenen, J. P., 16 Ball Street, College Station, Texas; U. of Calif., M.S., (Forestry), 1953.

Inland Empire Section

Associate Grade

Gilbertson, R. L., Asst. Prof., U. of Idaho, Moscow, Idaho; State U. of N. Y., Ph.D., (Mycology & Forest Pathology), 1954.

Intermountain Section

Student Grade

UTAH STATE AGRICULTURAL COLLEGE

Wheeler, R. A.

Junior Grade

Hawkes, L. E., 49 W. 2nd N., St. Anthony, Idaho. Reinstatement.

Ketchie, H. L., Forester, U.S.F.S., St. Anthony, Idaho; Utah State, B.S.F., 1937.

Welch, D. S., Forester, U.S.F.S., Ogden, Utah; U. of Wash., B.S.F., 1948.

Member Grade

Boyle, E. P., Dist. Ranger, U.S.F.S., Wellington, Nevada. (Junior, 1946).

Craft, A. D., Forester, Bur. of Land Mgmt., Boise, Idaho. (Junior, 1947).

Fickes, E. M., Ranger, U.S.F.S., Lowman, Idaho. (Junior, 1948).

Harris, G. A., Ext. Forester, Utah State Agric. College, Logan, Utah. (Junior, 1948).

Johannesen, M. M., Ranger, U.S.F.S., McCall, Idaho. (Junior, 1948).

Lambert, G. A., Dist. Forest Ranger, U.S.F.S., Vernal, Utah. (Junior, 46R54).

Peters, J. D., Dist. Forest Ranger, U.S.F.S., Ririe, Idaho. (Junior, 1948).

Wright, M. S., Dist. Forest Ranger, U.S.F.S., Tooele, Utah. (Junior, 1947).

Affiliate Grade

Zuberbuhler, U. H., Forester, U.S.F.S., St. Anthony, Idaho; Wash. State, B.S., (Range Mgmt.), 1940.

Kentucky-Tennessee Section

Junior Grade

Guthrie, R. L., Forester-Naturalist, Bernheim Forest, Clermont, Ky.; W. Va. Univ., B.S.F., 1953.

New England Section

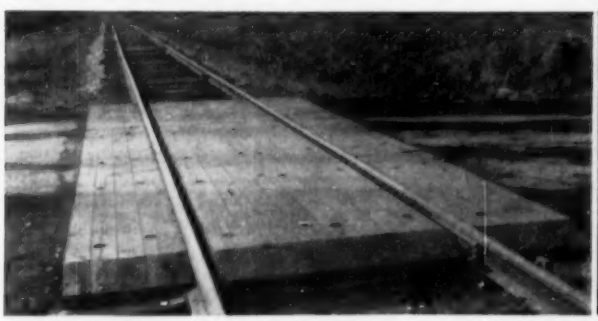
Student Grade

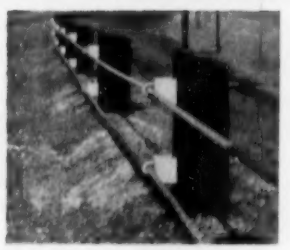
UNIVERSITY OF MAINE

Shaw, P. A.

Junior Grade

Natti, T., Hoyt Rd., Rt. 9, Concord, N. H. Reinstatement.





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New York Section

Student Grade

STATE UNIVERSITY OF NEW YORK

Kaulfuss, W. J. Schroeder, W. J.
Morse, P. E.

Northern California Section

Junior Grade

Kincaide, G., P. O. Box 71, Oroville, Calif. Reinstatement.
Williamson, M. D., Dist. Ranger, U.S.F.S., Soda Springs, Calif.; Pa. State, B.S.F., 1937.

Affiliate Grade

Miralles, R. E., Asst. State Ranger, Calif. Div. of Forestry, Porterville, Calif.; Wash. State, B.S. (Forestry), 1950.

Northern Rocky Mountain Section

Student Grade

MONTANA STATE UNIVERSITY

Wilson, H. J.

Junior Grade

Crowe, R. A., Lbr. Agent, Missoula White Pine Sash Co., Missoula, Mont.; Pa. State, B.S.F., 1951.

Ozark Section

Student Grade

UNIVERSITY OF MISSOURI

Boeckstiegel, L. L.

Junior Grade

Bruns, R. R., 9535 Miriam, Overland, Mo. Reinstatement.

Member Grade

Lary, G. A., Rt. 6, Box 833, Pine Bluff, Ark. Reinstatement.

Affiliate Grade

Gandy, W. V., 817 N. Main, Monticello, Ark. Reinstatement.
Sanders, W. F., Forest Tech., International Paper Co., Malvern, Ark.; Ark. A & M, B.S., (Forestry), 1951.

Puget Sound Section

Student Grade

Mason, B. J.

Junior Grade

Andreen, M. D., 910 W. 64th St., Seattle, Wash.; U. of Wash., B.S.F., 1955. (Student, 1954).
Heinrich, S. L., 4016 Union Bay Lane, Seattle, Wash.; U. of Wash., B.S.F., 1955. (Student, 1953).
Holbrook, W. G., Logging Mgr., M. C. Miller Lbr. Co., Cle Elum, Wash. Reinstatement.
Post, W. A., Tbr. Mgmt. Asst., U.S.F.S., Granite Falls, Wash.; Mont. State, M.F., 1952.
Sim, J. R., Forester, U.S.F.S., Shelton, Wash. Reinstatement.
Woodcock, R. H., Dist. Ranger, U.S.F.S., Darrington, Wash.; U. of Wash., B.S.F., 1939.

Affiliate Grade

Arneson, A. N., Woods Foreman, Cascade Lbr. Co., Naches, Wash.
Brigham, N. O., Tbr. Consultant, Cascade Lbr. Co., Yakima, Wash.
Engles, H. J., Dist. Forest Ranger, U.S.F.S., Darrington, Wash.
Johnson, C. J., Dist. Asst., U.S.F.S., Naches, Wash.
Wimer, C. C., Asst. Logging Supt., Cascade Lbr. Co., Yakima, Wash.

Southeastern Section

Junior Grade

Browne, T. H., Woodland Conservationist, Soil Cons. Service, Wrightsville, Ga. Reinstatement.
Cobb, F. W., Forester, Southeastern Forest Expt. Sta., Lake City, Fla.; N. C. State, B.S.F., 1955. (Student, 1952).
Lott, J. F., Mgmt. Forester, Hardin Lbr. Co., Forsyth, Ga.; Univ. of Ga., B.S.F., 1953.
Stuckey, W. N., P. O. Box 428, Bay Minette, Ala. Reinstatement.
Wilkins, W. B., P. O. Box 372, LaGrange, Ga.; U. of Ga., B.S.F., 1954.

Member Grade

Goodrich, H. L., P. O. Box 724, Tallahassee, Fla. Reinstatement.

Affiliate Grade

Butler, F. J., Dist. Forester, N. Ga. Timberland Co., Jasper, Ga.

Southwestern Section

Junior Grade

Casey, L. J., State Forester, Bur. of Land Mgmt., Albuquerque, N. Mex.; Mont. State, B.S.F., 1949.
Stricklin, H. B., Box 122, Grand Canyon Natl. Park, Arizona. Reinstatement.

Affiliate Grade

Bates, R. W., Asst. Dist. Ranger, U.S.F.S., Santa Fe, N. Mex.; Univ. of Idaho, B.S., (Range Mgmt.), 1951.

Upper-Mississippi Valley Section

Student Grade

IOWA STATE COLLEGE

Clark, K. D. Quade, R. L.
Merriman, M. M.

UNIVERSITY OF MINNESOTA

Davidson, R. R. Weissling, J. A.
Jaquith, P. H.

Junior Grade

Barrington, J. C., Box 78, Ames, Iowa; Iowa State, B.S.F., 1955. (Student, 1953).
Ford, R. P., Grad. Asst., Iowa State, Ames, Iowa; Iowa State, B.S.F., 1953.
Hunt, R. L., 787 Pammel Court, Ames, Iowa; Iowa State, B.S.F., 1955. (Student, 1955).
Johnson, V. A., 891 Pammel Court, Ames, Iowa; Iowa State, B.S.F., 1955. (Student, 1954).
Koenigs, J., Box 1107, St. Paul, Minn.; Univ. of Minn., B.S.F., 1954. (Student, 1953).
Johnson, H. C., 207 Stanton Ave., Ames, Iowa; Iowa State, B.S.F., 1955. (Student, 1954).
Schernick, J. L., Box 104, Clintonville, Wis.; Univ. of Minn., B.S.F., 1955. (Student, 1954).
Sheppard, J. E., 2137 Hoyt Ave. W., St. Paul, Minn.; Univ. of Minn., B.S.F., 1955. (Student, 1953).

Wisconsin-Michigan Section

Student Grade

UNIVERSITY OF MICHIGAN

Caddis, A. J.

Junior Grade

Cromell, W. H., Box 327, Munising, Mich.; Mich State, B.S.F., 1955. (Student, 1953).
Ellis, G. R., 202 W. Cedar St., Boyne City, Mich.; Mich. State, B.S.F., 1955. (Student, 1953).
Faull, W. G., 587 Cornell Ave., E. Lansing, Mich.; Mich. State, B.S.F., 1951.
Frankenfield, C. L., Forester, Detroit Edison Co., Pontiac, Mich.; Mich. State, B.S.F., 1921.
Hamilton, G., City Forester, Oak Park, Mich. Reinstatement.
Harpfer, H. E., 1322 Forest Ave., Ann Arbor, Mich.; Univ. of Mich., B.S.F., 1954.
Kortge, R. E., 1120 Fournie St., Midland, Mich. Reinstatement.
Ruppenthal, R. E., 427 Hawthorne Lane, E. Lansing, Mich.; Mich. State, B.S.F., 1955. (Student, 1953).
Russell, R. G., 901 Sheridan St., Lansing, Mich.; Mich. State, B.S.F. 1955. (Student, 1953).
Stipe, R. L., Forester, Upper Peninsula Power Co., Houghton, Mich.; Mich. College of Mining & Tech., B.S., (Forestry), 1950. (Affiliate, 1952).
Veeser, W. L., Head, Land & Forestry Dept., Upper Peninsula Power Co., Houghton, Mich.; Mich. College of Mining & Tech., B.S., (Forestry), 1949. (Affiliate, 1952).
Williams, C. B., 411 Longshore Dr., Ann Arbor, Mich.; Univ. of Mich., B.S.F., 1955. (Student, 1955).

Affiliate Grade

Anderson, L. F., Wood Procurement, Cliffs-Dow Chemical Co., L'Anse, Mich.
Makinen, R. L., 312 S. Maple, Manistique, Mich. Reinstatement.

Foreign

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Butler, A. P., Firestone Plantations Co., Harbel, Liberia, W. Africa. Reinstatement.

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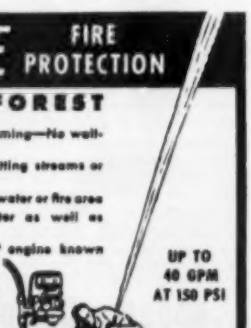

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Coming Events

Northern California Section

The summer meeting of the Northern California Section will be held June 3 and 4. Members will register at Jackson, Calif., on June 3.

Ozark Section Meeting

The summer meeting of the Ozark Section will be held July 22-23 at Tulsa, Okla. The program will feature reclamation of coal strip mines.

Allegheny Section Summer Meeting

The summer meeting of the Allegheny Section has been set for August 5 and 6 at the Fernow Experimental Forest, Elkins, W. Va.

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Forestry News

FIELD HEADQUARTERS of the Southern Institute of Forest Genetics near Gulfport, Mississippi.

Dedication of Southern Institute of Forest Genetics

The Southern Institute of Forest Genetics, Gulfport, Mississippi, was officially dedicated March 3, 1955, at its field headquarters on the nearby Harrison Experimental Forest. Over 200 people attended the ceremony, which was held in conjunction with the annual meeting of the Forest Farmers Association.

The Institute was established July 1, 1954, by the Forest Service of the U. S. Department of Agriculture, to further research on the genetics of forest trees, particularly the southern pines. Fundamental aspects of forest genetics are to be stressed, but not to the exclusion of local and Southwide problems of immediate importance in forest tree improvement. The Institute is a branch of the Southern Forest Experiment Station, with headquarters at New Orleans, Louisiana.

Mr. P. A. Briegleb, director of the Southern Forest Experiment Station, presided at the dedication ceremony. Professor R. T. Clapp, head, Department of Forestry, Mississippi State College, and Mr. J. V. Whitfield, president of the Forest Farmers Association, were guest speakers. They emphasized the importance of research in tree improvement and the significance of the establishment of the new Southern Institute. Dr. V. L. Harper, assistant chief, U. S. Forest Service, described the purpose and functions of the new Institute.

To symbolize the origin of forest genetics in the South, Dr. Harper presented to Dr. B. W. Henry, leader of the Southern Institute, a grafted scion of the first man-made hybrid of the southern pines. Dr. Henry in turn handed it to Mr. P. C. Wakeley, a long-time member of the Southern Forest Experiment Station, who "plunged" it into the soil. Mr. Wakeley had crossed longleaf and slash pine in 1929 to create the first hybrid from which this scion was an offshoot.

Mr. R. M. Allen, of the Institute staff, demonstrated modern techniques in bagging and artificially pollinating pine flowers. Mr. G. F. Erambert, Ashe Nursery, U. S. Forest Service, Brooklyn, Miss., showed how valuable plant material may be perpetuated by grafting.

At the conclusion of the program, a "chuck wagon" dinner was served through the courtesy of the International Paper Company and the Gaylord Container Corporation.

Southern Forestry Conference Held

Sponsored by the Forest Farmers Association, the 1955 Southern Forestry Conference attracted nearly 300 delegates from 15 states to its March 3-4 meeting at Edgewater Park, Mississippi. Theme of the meeting was "Forest Farming for 1975," a subject viewed by the conference in the light of an era of unparalleled development for the South's wood economy. The conference presented numerous highlights of progress in southern forestry to bear out its optimism, an optimism which was perhaps most strikingly expressed in the words of keynote speaker Clayton Rand, "These are exciting times."

Resources for the Future Grant to Institute of Forest Genetics

Research on the basic processes of flowering and seed production in pine trees is to be started by the Institute of Forest Genetics of the California Forest and Range Experiment Station, U. S. Forest Service, with the aid of a grant from Resources for the Future, Inc.

George M. Jemison, director of the experiment station has announced that $35,700 has been granted to the station for a five-year study. Resources for the Future is a nonprofit organization for research and education in the development and conservation of natural resources.

Dr. N. T. Mirov, plant physiologist in the experiment station will be responsible for the new research project. He is internationally known for his fundamental studies in the biochemistry of pine turpentines and the inheritance of chemical characters.

The project is expected to start in July 1955. Chemical and anatomical studies of pine flowering will be conducted in laboratories on the Berkeley campus of the University of California and at the Institute of Forest Genetics, near Placerville.

Field studies also will be carried on at the Institute, where one of the world's outstanding collections of pine trees is growing in the Eddy Arboretum for use of Forest Service tree breeders.

Tally Made of North Carolina Foresters

The Forestry Division of the North Carolina Department of Conservation and Development has recently compiled and published a list of the practicing foresters whose addresses are within the boundaries of the state. The list does not include individuals trained in forestry but not actively engaged in forestry work, nor out-of-state foresters who may carry on work within the state.

As of March 1955, North Carolina had 305 practicing foresters. Of this total 132 were classified as industrial and corporation foresters and 33 as consulting foresters. The remainder included those with federal agencies, state agencies, schools, and associations.

Southern Pine Annual Convention Held

The 40th annual convention of the Southern Pine Association was held in New Orleans, April 4-6 and drew a large attendance. Progress of the southern pine lumber industry was summarized in terms of mechanization, quality improvement, and cost reduction. Major problems were analyzed and means of solutions presented while steps were taken to consolidate and further current research work.

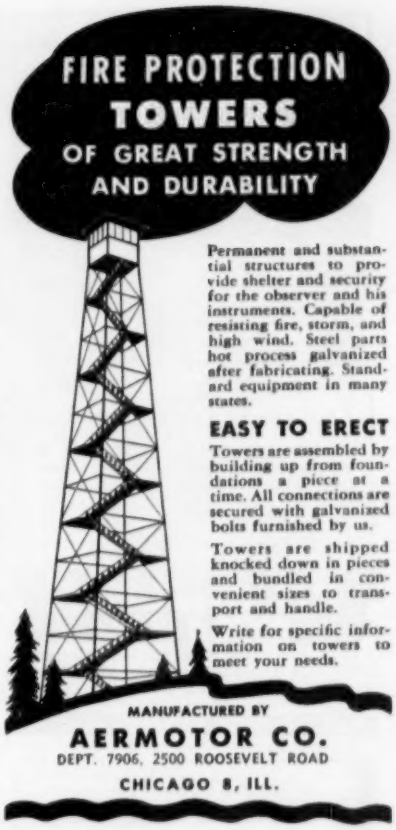
Allied

American Institute of Biological Sciences Meeting

The American Institute of Biological Sciences governing board met April 23, 1955 in Washington, D. C. About 35 persons attended, including observers and guests. The Institute was incorporated in January 1955, severing its connection with the National Research Council, and has set up headquarters at 2000 P St., N. W., Washington, D. C.

Dr. Hiden T. Cox has accepted a full-time position as executive secretary effective July 1. Including grants from the Office of Naval Research and National Science Foundation, the budget for 1956 will be nearly $100,000.

Two new committees were authorized: (1) Biological Education, and (2) Basic Biological Research in Aging. The U. S. Office of Education has requested assistance from AIBS on accreditation of biology departments. The Publications Committee has asked the National Science Foundation to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back a new model of the Shaw selector; a code system for machine analyses of biological data, and a meeting of editors of biological journals. The AIBS representatives on the Scientific Manpower Commission were asked to support the principles of HR 2442, to remove some of the inequities now existing in the armed forces of Ph. D. people as compared with M. D.'s and D. V. M.'s

The Society of American Foresters is an Affiliate of AIBS, not a full member.

Industrial & Private

P. F. Liniger Joins Industrial Forestry Association

Paul F. Liniger has been added to the staff of the Industrial Forestry Association, according to W. D. Hagenstein, managing director.

There are now six graduate foresters with I.F.A. available to private forest owners in the Douglas-fir region. The staff has been spending more and more time in recent years, Hagenstein reports, helping smaller landowners with their forestry problems. Improved standards of forest protection, better management of young timber, higher utilization, and better trees for the future are the principal objectives of the Association.

I.F.A. operates the Forest Industries Tree Nursery at Nisqually, Wash.

PAUL F. LINIGER

where 8 million trees are raised each year. The Association is the certifying agency for West Coast tree farms and regularly inspects these properties to insure good forest practices.

Liniger graduated in 1939 from the College of Forestry, University of Washington, and his professional experience includes several years with the U. S. Forest Service, with a consulting forest engineering firm, and with several forest industry companies, including C. D. Johnson Lumber Corporation.

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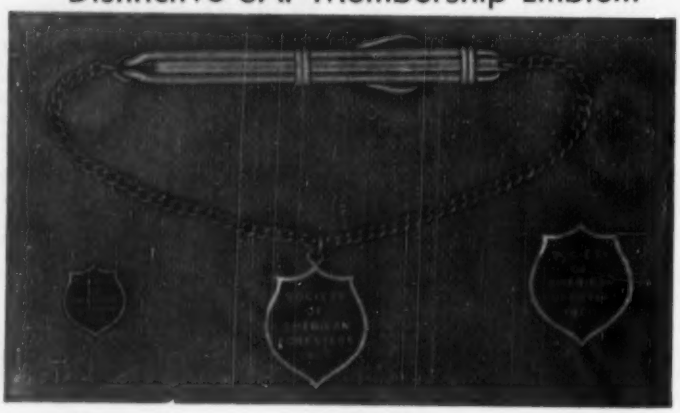

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J. F. Spiers Joins Pulpwood Conservation Association

James F. Spiers has recently resigned as forester for the Central of Georgia Railroad Company to accept the position of area forester with the Southern Pulpwood Conservation Association. He will have headquarters at Statesboro, Ga.

Mr. Spiers is vice chairman of the Southeastern Section, Society of American Foresters.

Fifteenth Anniversary of Keep Washington Green

The fifteenth anniversary of the Keep Washington Green Program was marked by an Annual Governor's Keep Washington Green Banquet, sponsored jointly by the Puget Sound Section of the S.A.F. and the K.W.G. Association, and by messages of congratulation from President Eisenhower, S.A.F. President Demmon, and Forest Service Chief R. E. McArdle.

Held annually, this banquet marks the start of the forest fire prevention season. K.W.G. Director M. P. Lazara reports with pride that the Keep Green program, now nationwide, has produced notable results in his state since its founding in 1940. For the years 1925-1939 Washington had an average annual fire loss of about 175,000 acres. Since 1940 the average annual loss has been less than 29,200 acres.

WASHINGTON GOVERNOR ARTHUR B. LANGLIE cuts the first slice of cake at this year's Annual Governor's Keep Washington Green Banquet. Shown with him are state Supervisor of Forestry L. T. Webster, and Miss Keep Washington Green for '55, Miss Ariel Dunbar. (See accompanying story).

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St. Regis Fellowship Awarded T. W. Beers

St. Regis Paper Company announces the award of its Fellowship in Forestry to Thomas W. Beers, a senior at the School of Forestry, Pennsylvania State University, and a student member of the S.A.F. Beers will receive his Bachelor of Science Degree in June, and plans to continue his forestry education at the Pennsylvania school in September. He will use his grant, valued at $1,000, to study forest management, with a contemplated special problem dealing with the management of Virginia pine for pulpwood utilization.

The committee responsible for making the award was composed of R. E. McArdle, chief of the U. S. Forest Service; V. L. Harper, in charge of the Forest Service Division of Research; Paul M. Dunn, technical director of forestry for St. Regis Paper Company; and W. R. Adams, vice president in charge of manufacturing of St. Regis.

This is the third St. Regis Fellowship in Forestry to be awarded to degree holders planning to take graduate work at any accredited school of forestry in the United States. Also for the third year, St. Regis offers five undergraduate scholarships in forestry, for which applicants may file up to September 1, 1955. Three are available in the South, one each in the Northwest and Northeast.

N.I.M.A. Awards Four Scholarships

Four forestry school students have been awarded $500 scholarships by the National Lumber Manufacturers Association.

Each scholarship winner will receive a cash award of $500 and ten weeks' training in wood technology and utilization this summer at the Washington, D. C. laboratory of the Timber Engineering Co., research affiliate of N. L. M. A.

The winners, chosen from students nominated by 11 of the nation's forestry schools, are: Henry Albert Huber, University of Michigan; Donald Charles Markstrom, University of Minnesota; Kennedy Alfred Wanner, Montana State University; and Thomas Joseph Patterson, Oregon State College.

Education

J. Whitney Floyd in Iran

J. Whitney Floyd, chief forester-fire warden of Utah, and a member of the forestry faculty of Utah State College, is in Iran as a forestry consultant on a six-month assignment under the FOA technical assistance program. He is associated with the development of a forest ranger school, originally proposed by Lewis M. Turner who had been in Iran on a similar assignment. In addition, Mr. Floyd will advise on windbreak and shelterbelt plantings in the arid part of the country.

He expects to return to the United States in October.

C. J. Holcomb Appointed V.P.I. Extension Forester

The Virginia Polytechnic Institute Agricultural Extension Service has announced the appointment of Carl J. Holcomb as extension forester. He will head up the four-man program of V.P.I. in the State of Virginia.

Mr. Holcomb undertook his new duties April 16, leaving the position of research forester at Elkins, W. Va., with the U. S. Forest Service. He is a

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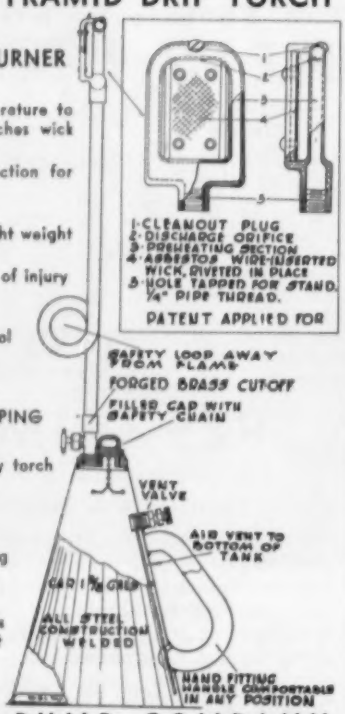

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1934 forestry graduate of Michigan State College.

Holcomb succeeds J. Wilbur O'Byrne, who held this position for 29 years before retiring June 30, 1954.

Oregon Faculty Promotions

J. R. Dilworth, associate professor of forest management at the School of Forestry, Oregon State College, has been promoted to head of the department. He succeeds W. F. McCulloch, who became dean of the School of Forestry upon the resignation of former dean Paul M. Dunn on January 1.

Another forestry school change announced was the assignment of George H. Barnes as director of the forest experiment station. He is also professor of forest management.

Dilworth is a graduate of Iowa State College with the class of 1938 where he received his master's degree. He is completing his doctorate at the University of Washington.

Fire Topic of Louisiana Symposium

Nearly 400 southern foresters attended the Fourth Annual Forestry Symposium at Louisiana State University, Baton Rouge, to discuss modern forest fire management in the South.

Charles A. Connaughton, regional forester, U. S. Forest Service, Atlanta, served as moderator of the symposium, with Professor A. Bigler Crow of the L. S. U. School of Forestry serving as general chairman.

The two-day April meeting presented an array of speakers and of topics which ranged from blow-up fires, through prevention activities, and prescribed burning.

Yale Holds Industrial Forestry Seminar

Executives in the field of industrial forestry attended a series of seminar refresher courses in forest management and industrial administration at Yale University during April.

The two-week session was the first of its kind in the country, according to George A. Garratt, dean of the Yale School of Forestry.

Teachers of the seminars included Yale forestry faculty members as well as leading experts both in government and business.

The new program was established at Yale to help industrial foresters study modern methods of business administration, particularly in the forest industry. Accordingly, the program is geared for industrial foresters, executives, logging superintendents, and management representatives.

Ernest T. F. Wohlenberg, professor of industrial forestry at Yale, directed the seminar.

New Forestry Building Started at Louisiana State

Dr. Paul Y. Burns, director of the School of Forestry at Louisiana State University, Baton Rouge, has announced start of construction of a new $300,000 building for the school. Completion is expected in the fall of 1955. The building will provide spacious quarters and is to be paneled with woods native to the state.

The School of Forestry was founded 31 years ago and accredited by the Society of American Foresters in 1937.

Government

F. C. Simmons, F. L. Stillings on Honduras Assignment

Frederick C. Simmons and Fred L. Stillings of the U. S. Forest Service left in April for a six-week's Technical Assistance detail to British Honduras with the Foreign Operations Administration.

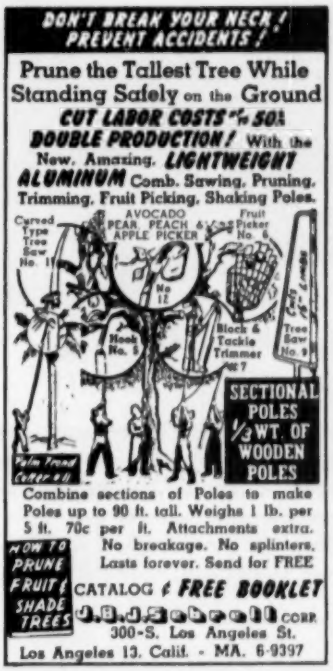
Honduran officials are interested in the possibility of putting their forest products industry on a better footing so far as processing methods and techniques are concerned and in improving logging equipment and methods of road construction. Ninety percent of the total land area of the country is in forests, largely hardwood.

Simmons is with the Forest Utilization Service, Northeastern Forest Experiment Station, and Stillings is with the Division of Timber Management, California Region.

J. B. Spring Promoted to Supervisor

John B. Spring was recently promoted to supervisor of the Cherokee National Forest, replacing William Paddock, who was transferred to Chequamegon National Forest as supervisor.

Mr. Spring, prior to his recent promotion, had served in the Atlanta regional office since 1952 as assistant in the Division of Lands, Recreation, Wildlife, Range, and Watershed Management.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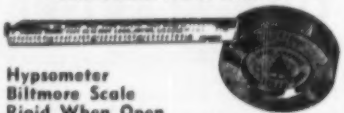

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Interior Reports on 1954 Timber Harvest, Fire Losses

The U. S. Department of the Interior reports that the 1954 calendar year timber harvest from lands under its administration totaled 1,474,088 M board feet. This is a slight increase over 1953's 1,348,711 M board feet. Stumpage prices averaged $17.69 per M, $1.58 above 1953 prices, and $13.96 above the 1944 average price of $3.73. Totals for 1954 by Interior bureaus: Indian Affairs, 638,156M; Bureau of Land Management, 813,881M; Fish and Wildlife Service, 10,541M; Park Service, 11,466M (salvage); Bureau of Reclamation, 44M.

Fires on Interior's forest and range lands in calendar year 1954 totaled 2,274 and burned on 1,624,701 acres. This is 443 fires less than in 1953 and 269 less than the average for the past 10 years. The total acreage, however, contrasts with 548,269 in 1953. and 976,817 for the 10-year average. The number of fires over 100 acres has continued to decrease.

W. R. Chapline Returns from Two Years Foreign Service

Wm. Ridgely Chapline, internationally known for his work in rangeland management, has returned after more than two years of service overseas.

Mr. Chapline, formerly chief, Division of Range Research, U. S. Forest Service, served from November 1952 to May 1954 as a consultant and chief of the Forest Conservation Section of the Forestry Division of the Food and Agriculture Organization of the United Nations. In this position emphasis was placed upon a review of the world situation relating to forest grazing, watershed management, torrent control, and shifting cultivation, and possibilities for betterment. Visits were made to various European and African areas where forest, range, and watershed situations were considered and reported upon.

An international meeting on forest grazing was held in the spring of 1954 in Rome at which a worldwide policy was developed and approved.

In the autumn of 1954, Mr. Chapline served as professor in the Second International Course on Study and Management of Pastures given by the Interamerican Institute of Agricultural Sciences, Southern Zone, Montevideo, Uruguay. This course for graduate agronomic engineers drew members from Uruguay, Brazil, Paraguay, Chile, and Venezuela.

National Forest Experiment Station in Colombia

A National Forest Experiment Station, the first in the nation, has been established in Antioquia, Colombia, S. A. It is a cooperative project on the part of the municipality of Medellín, the Forestry Institute of the College of Agriculture, National University, the Ministry of Agriculture, and the U. S. Point IV technical assistance program of which Eugene C. Reichard is the representative in Bogotá of FAO's Institute of Inter-American Affairs.

The experiment station is on the watershed of Piedras Blancas Creek where the city of Medellín owns 1,800 hectares of forest land. It is one of the largest experimental forests in South America.

The Forestry Institute, staffed by Colombian and American Foresters with technical direction from Michigan State College and the Point IV program, will provide scientific guidance for the research projects. The technical administration will be headed by a graduate of the College of Agriculture in Medellín who recently completed advanced studies in forestry at Michigan State College.

For many years the forests of Colombia have been deteriorating, with consequent serious soil erosion and loss of water supplies. Because of these problems, coupled with lack of technical skills for reconstruction of the resources involved, the establishment of the National Forest Experiment Station is of especial significance.

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Game Food and Cover Will be Studied by Southern Experiment Station

Food and cover for game in the forests of the South is the subject of a research program announced by Philip A. Briegleb, director of the Southern Forest Experiment Station.

Improved forest protection and game management have increased the numbers of game animals, introducing a number of questions concerning management of game habitat as related to management practices of forest lands.

As the program develops, the studies will be incorporated into the work of the Station's research centers in Texas, Arkansas, Louisiana, Mississippi, and Alabama. The research will be done in cooperation with state game agencies and the U. S. Fish and Wildlife Service.

The new program will be under the direction of Dr. R. S. Campbell, chief of the Division of Range and Watershed Management Research at the Station, and will be supervised by Hubert D. Burke.

J. H. Stoeckeler to Study Lake States Soil-Site Relationships

Joseph H. Stoeckeler has been transferred to the St. Paul, Minn. office of the Lake States Forest Experiment Station to conduct research on soil-site relationships of the major forest types in the region, according to M. B. Dickerman, director of the station.

Mr. Stoeckeler, a graduate of Iowa State College, has been doing research work, mostly in the Lake States region, for the U. S. Forest Service, for 23 years. Since 1946 he has been in charge of the Northern Lakes Research Center at Rhinelander, Wisconsin. This center is a field unit of the Lake States Station where management problems of northern and central Wisconsin are studied. Mr. Stoeckeler is a specialist in reforestation problems and forest nursery practices.

In the past few years, some work has been undertaken on the relation of aspen tree growth to soil quality. Additional studies of this nature will be initiated in some of the other important forest types in the Lake States.

Report Issued on Survey of Louisiana's Forests

Louisiana's forests are growing more timber than is being cut, according to a new survey of the state's forest resources, issued by the U. S. Forest Service. Because stands are understocked, however, growth is only about half the potential yields.

This survey was made by the Southern Forest Experiment Station at New Orleans. Completion of the survey was advanced 2½ years through the cooperation of the Louisiana Forestry Commission and private organizations and individuals.

Louisiana's forests are growing 716 million cubic feet of timber annually, of which 2.8 billion board feet is saw timber. In 1953, when the latest cutting statistics were compiled, 366 million cubic feet of timber were logged, 1.4 billion board feet of which were saw timber.

Forests cover 16,128,900 acres of the state's total land area of 28,903,700 acres. This is about the same total acreage as in the middle 1930's, when the first survey of Louisiana's forests was made.

Louisiana's supply of all merchantable trees of pole-timber-size or larger totals 12 billion cubic feet. This is about 5 percent more total volume than in 1934-35. Softwood volume, which includes the southern yellow pines as well as cypress and cedar, increased 11 percent; hardwood increased 2 percent.

Saw-timber volume is 45 billion board feet, an increase of 1 percent. Hardwood volume dropped 6 percent since the initial survey. Softwood volume, however, increased 12 percent.

Louisiana's extensive forest resources support some 500 sawmills, 8 wood-pulp mills, and about 80 miscellaneous wood-using plants. The 8 pulp mills are now using more pine annually than the state's several hundred sawmills, the survey found.

A full report of the survey may be obtained from the Southern Forest Experiment Station, 2026 St. Charles Ave., New Orleans 13, La.

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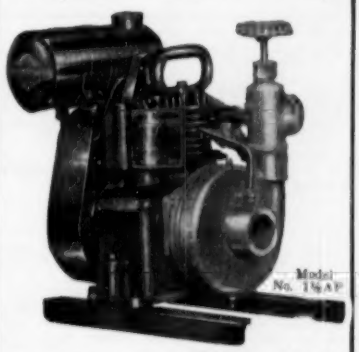

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Box D, Journal of Forestry, Mills Building, Washington 6, D. C.

Forestry Employment

S.A.F. members are privileged to insert one 60-word advertisement in this column without charge. Forest industries desiring to employ foresters may insert advertisements at the rate of $4 per column inch. Copy must be received by the end of this month for an advertisement to appear in the issue after next.

Obviously, the Society cannot assume responsibility beyond making it possible for prospective employee and employer to enter into negotiations.

Positions Wanted

Graduate forester, B.S.F., Michigan State College, 1949; AbB., Miami University, 1947. Age 30, married, one child, veteran. Now state employed. Four years experience, administration and supervision of fire control, education, and forest management activities; two years wholesale lumber business. Presently employed in south; desire to relocate in Midwest or northeast states in management or allied field.
Box B, Journal of Forestry, Mills Building, Washington 6, D. C.

Forester, 32, B.S.F., L.S.U., now employed as civilian flight instructor at USAF Primary Contact School in Florida desires forestry job in West, preferably California, with private or government organization. 3000 hours flying time in single and twin-engine aircraft and experience in aerial photo work. Forestry experience in utilization and sawmill operation. Prefer job requiring flying full or part time but will consider any work in forestry or allied fields with opportunities for responsibility and advancement. Top recommendations. Please state salary.
Box E, Journal of Forestry, Mills Building, Washington 6, D. C.

T. H. Trosper to Head Bitterroot National Forest

Thurman H. Trosper, who has been serving as assistant supervisor of the Clearwater National Forest in north Idaho, was named as supervisor of the Bitterroot National Forest, Regional Forester P. D. Hanson announced recently. Mr. Trosper succeeds G. M. Brandborg who retired on March 31st after more than 30 years service. Trosper assumed his new duties on May 1st, at the forest headquarters in Hamilton, Montana.

Mr. Trosper's professional forestry experience involves timber sale work on the Kootenai, special assignments in the field of timber management and a period of several years as district ranger at Libby, Montana. Since 1951 he has been on the staff of the forest supervisor at Orofino, Idaho.

J. O. Lammi to FAO Position in Switzerland

Joe O. Lammi, formerly engaged in forest economics research at the Intermountain Forest and Range Experiment Station, recently left for Geneva, Switzerland, where he has accepted a position with the Economic Unit of the Food and Agriculture Organization of the United Nations. The office is maintained in Geneva especially for close collaboration with the Economic Commission for Europe, including its Timber Committee. Lammi will edit the English portions of the marketing and commodity reports issued by the Economic Unit and will help organize statistical material in connection with the Year Book of Forest Products Statistics and quarterly bulletins on forest products issued by FAO. He will be drawn in on economic studies not only for Europe but also those conducted on a worldwide basis, such as the World Forest Inventory.

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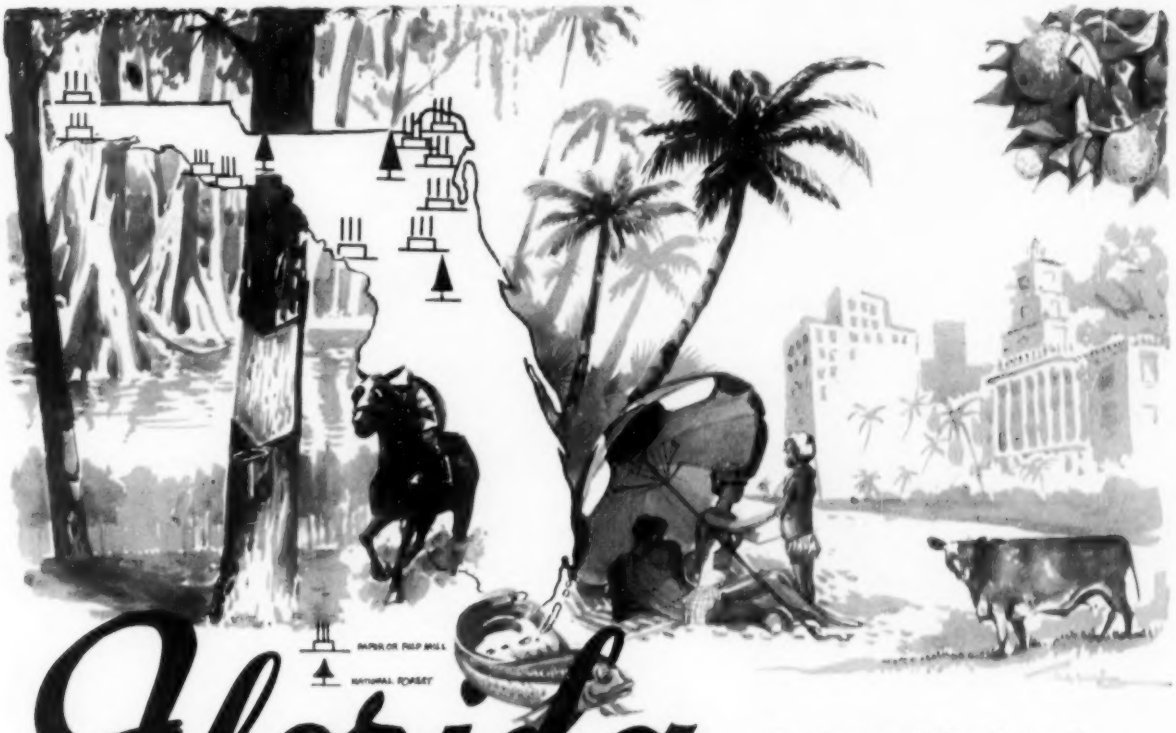
No. 8 of a series featuring state forestry practices, projects and products . .



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